PK
w/o

MATERIALS BUREAU

TECHNICAL REPORT 87-1

ASPHALT CEMENT MONITOR PROGRAM

FALL 1986

MARCH 1987

M.A.P. CODE 7.42-6-87-1

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
MARIO M. CUOMO, Governor FRANKLIN E. WHITE, Commissioner

TECHNICAL REPORT 87-1

ASPHALT CEMENT MONITOR PROGRAM
FALL 1986

Prepared by

Ronald L. Zack
Senior Engineering Materials Chemist

Justin L. Brennan
Engineering Materials Technician

March 1987

MATERIALS BUREAU
JAMES J. MURPHY, DIRECTOR

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVENUE, ALBANY, N.Y. 12232

M.A.P. CODE 7.42-6-87-1

Preface

Each year the Materials Bureau conducts a monitor testing program in cooperation with various suppliers of asphalt cement. Samples are obtained by Bureau personnel and split for testing by both the supplier and the Bureau in accordance with standard AASHTO test procedures. This report summarizes the results of the 1986 program.

TABLE OF CONTENTS

I. Introduction

During July and August 1986, personnel from the Materials Bureau Chemistry Laboratory Section obtained twenty-eight samples from eighteen suppliers of asphalt cement. These samples represented many of the sources which had supplied material to the Department during the 1986 construction season including Boscan, Maya, Mid-Continent, Canadian, Arab, Venezuelan and other various crude sources.

At the time of sampling, the twenty-eight samples were split into two parts. One part was given to the asphalt supplier while the other was returned to the Bureau's Laboratory. All tests were conducted in accordance with the applicable AASHTO test procedures.

Two standard test report forms and one sample identification form were provided by the Bureau for recording sample information and all test results. Each supplier submitted the test results to the Bureau for review and incorporation into this report.

II. Sample Information

A. The distribution of the samples by grade was as follows:

Grade	Number of Samples
Flux	3
AC-5	2
AC-10	2
AC-15	6
AC-20	11
85/100	4

B. The supplier, location, crude source and lot numbers are tabulated below.

Flux

Supplier	Location	Lot	Crude Source
Chevron	Perth Amboy, NJ	18	Mexico Mayan
Cibro	Albany, NY	35	Boscan
Marathon	Tonawanda, NY	16	Mid-Continent and Canadian

AC-5

Supplier	Location	Lot	Crude Source
Parco	Athens, NY	-	Meni-Mota
Petro-Canada	Oakville, Ont.	220	Western Canadian

AC-10

Supplier	Location	Lot	Crude Source
Parco	Athens, NY	16	Meni-Mota
Petro-Canada	Montreal, Que	12	Venezuelan Canadian

AC-15

Supplier	Location	Lot	Crude Source
Marathon	Tonawanda, NY	14	Mid-Continent and Canadian
NoCo Energy	Tonwanada, NY	6	Western Canadian
Petro-Canada	Oakville, Ont.	240	Western Canadian
Shell Canada	Hamilton, Ont.	1	Venezuelan
United Refining	Warren, PA	8	Canadian
Warden	Pittsford, NY	34	Canadian

AC-20

Supplier	Location	Lot	Crude Source
Atlantic Refining	Philadelphia, PA	60	Merey, Bachaquero
Chevron	Perth Amboy, NJ	19	Mayan Boscan
Cibro	Albany, NY	36	Boscan
Exxon	Linden, NJ	21	Mayan
Mantua	Paulsboro, NJ	28	Western Venezuelan
Marathon	Tonawanda, NY	15	Mid-Continent and Canadian
Parco	Athens, NY	17	Meni-Mota, Tijuana Pesada
Peckham Materials	Stamford, CT	28	Venezuelan
United Refining	Warren, PA	14	Canadian
Warden	Pittsford, NY	27	Canadian
West Bank Oil	Perth, Amboy, NJ	8	Venezuelan

85/100

Supplier	Location	Lot	Crude Source
Esso-Canada	Montreal, Que.	1	Venezuelan, Canadian
Petro Canada	Montreal, Que.	13	Venezuelan, Canadian
Shell Canada	Montreal, Que.	9	Canadian, Mexican
Ultramar	Montreal, Que.	3	Venezuelan

III. Test Performed

A. Tests required by Department of Transportation Specification: (all tests not required on all items of asphalt cement)

1. Viscosity @ 140°F, Absolute, (AASHTO T202)
2. Viscosity @ 275°F, Kinematic, (AASHTO T201)
3. Penetration @77°F, (AASHTO T49)
4. Ductility @ 39.2°F, (AASHTO T51)
5. Flash Point, Cleveland Open Cup, (AASHTO T48)
6. Solubility in Trichloroethylene, (AASHTO T44)
7. % Loss on Thin Film Oven Test Residue, (AASHTO T179)
8. Penetration @77°F on Thin Film Oven Test Residue (AASHTO T49)
9. Penetration @ 77°F Ratio (% of Original) between the Thin Film Oven Test Residue and the Penetration @ 77°F on the original sample.
10. Viscosity @ 140°F, Absolute on Thin Film Oven Test Residue (AASHTO T202)
11. Ductility @ 77°F on Thin Film Oven Test Residue (AASHTO T51)

B. Additional tests not required by Department of Transportation Specifications:

1. Penetration @ 39.2°F (AASHTO T49)
2. Penetration Ratio: 39.2°F/77°F
3. Ductility @ 77°F, (AASHTO T51)
4. Specific Gravity @ 77°F (AASHTO T228)
5. Softening Point, Ethylene Glycol (AASHTO T53)
6. Viscosity @ 275°F, Kinematic, on Thin Film Oven Test Residue (AASHTO T201)
7. Ductility @ 60°F on Thin Film Oven Test Residue (AASHTO T51)
8. Viscosity @ 140°F, Absolute, Ratio, between viscosity @ 140°F, Absolute on Thin Film Oven Test Residue Sample and the original sample.
9. A Settling Test to Evaluate the Relative Degree of Dispersion of Asphaltenes.
10. Separation of Asphalt into Four Fractions, (Modified Method of ASTM D 4124-84).

C. A Penetration Viscosity Number (PVN) and a Penetration Index Number (PIN) has been computed for each asphalt cement sample.

IV. Test Data and Sample Identification Forms

On the following pages are the Standard Test Report and Sample Identification Forms used for this project.

PRIMARY SOURCE	LOCATION
CRUDE SOURCE	SAMPLED AT
SAMPLED BY	DATE SAMPLED
ITEM NO.	GRADE TYPE
LOT NO.	DATE OF CERTIFICATION

REMARKS:

NEW YORK STATE

DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
1986 ASPHALT MONITOR PROGRAM

TEST NO.

PRIMARY SOURCE	LOCATION

LOT NO.	ITEM NO.	GRADE TYPE

CRUDE SOURCE	AASHTO	RESULTS
1. Viscosity Ratio @ 140°F		
a.) Viscosity of Original Sample, (poises)	T 202	
2. Viscosity @ 275°F, Centistokes	T 202	
3. Penetration @ 77°F, 100g., 5 sec.	T 201	
4. Penetration @ 39.2°F, 200g., 60 sec.	T 49	
5. Penetration Ratio (39.2°F/77°F) 100		
6. Ductility @ 39.2°F, 1 cm/min., cm.	T 51	
7. Ductility @ 77°F, 5cm/min., cm.	T 51	
8. Flash Point C.O.C., F	T 48	
9. Solubility in Trichloroethylene	T 44	
10. Loss on Heating T.F.O.T., Percent, 325F @ 5 Hrs.	T 179	
11. Specific Gravity @ 77°F	T 228	
12. Ductility @ 60°F, T.F.O.T., 5cm/min., cm.	T 51	
13. Ductility @ 77°F, T.F.O.T., 5cm/min., cm.	T 51	
14. Penetration @ 77°F, T.F.O.T., 100g., 5 sec.	T 49	
a.) Percent of Original		
15. Viscosity @ 275°F After T.O.F.T. (cst)	T 201	
16. Penetration Viscosity Number, PVN		
17. Softening Point, Ethylene Glycol, °F	T 53	
18. Penetration Index Number, PIN		

NEW YORK STATE

DEPARTMENT OF TRANSPORTATION

MATERIALS BUREAU

1986 ASPHALT MONITOR PROGRAM

			TEST NO.
PRIMARY SOURCE		LOCATION	
LOT NO.	ITEM NO.	GRADE TYPE	
CRUDE SOURCE			

ASPHALT COMPOSITION ANALYSIS

ASPHALTENES, %	
SATURATES, %	
NAPHTHENE AROMATICS, %	
POLAR AROMATICS, %	

A Settling Test to Evaluate the Relative Degree of Dispersion of Asphaltenes

SETTLEMENT TIME, MINUTES	

V. NEW YORK STATE DEPARTMENT OF TRANSPORTATION SPECIFICATIONS FOR ASPHALT CEMENT

TABLE 702-1

ASPHALT CEMENTS FOR PAVING

MATERIAL DESIGNATION	702-0100		702-0200		702-0300		702-0400		702-0500	
VISCOSITY GRADE	AC-2.5		AC -5		AC-10		AC-15		AC-20	
Test Requirements	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity 140°F (60 C), P	200	300	400	600	800	1200	1200	1800	1600	2400
Viscosity 275F(135 C), cSt	125	—	175	—	250	—	275	—	300	—
Penetration 77F (25C),100g, 5s	200	325	120	200	70	120	60	100	60	100
Flash Point COC,°F(C)	325(163)		350(177)		425(219)		435(225)		450(232)	
Solubility in Trichloroethylene, %	99.0		99.0		99.0		99.0		99.0	
Tests on Residue from Thin Film Oven Test										
Viscosity, 140°F(60C), P	—	1250	—	2500	—	5000	—	7500	—	10,000
Ductility, 77°F(25C) 5 cm/min., cm	100	—	100	—	75	—	60	—	50	—
TYPICAL USES (intended only as a general information guide)	Recycle Mix		Hot plant mix very cold climate. Recycle Mix.		Hot plant mix cold climate. Recycle Mix.		Hot plant mix moderate climate.		Hot plant mix moderate climate. Sheet mixes. Open graded surface course mixes.	

TABLE 702-2

MISCELLANEOUS ASPHALT CEMENTS

MATERIAL DESIGNATION	702-0600	
GRADE	85/100	
TEST REQUIREMENTS	Min	Max
Penetration,77F(25C), 100g, 5s	85	100
Viscosity,275F(135C), cSt	280	—
Flash Point, COC, F	450	—
Solubility in trichloroethylene, %	99.5	—
Ductility, 39.2F(4C), 1cm/min., cm	6	—
Tests on residue from Thin-film Oven Test (AASHTO T179)		
Loss on Heating, 325F, 5h, %	—	.85
Penetration, % original	47	—
Ductility, 77F(25C), 5cm/min., cm	75	—
Typical Uses	Hot plant mix moderate climate	

SPECIFICATION
CHEVRON
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	600	800
Viscosity, 275F(135C), cst	200	-
Penetration, 77F(25C), 100g., 5 sec.	140	190
Flash Point, C.O.C.,°F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	3200
Ductility, 77F(25C), 5cm/min., cm.	100	-

SPECIFICATION
CIBRO
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	800	1200
Viscosity, 275F(135F), cst	175	-
Penetration, 77F(25C), 100g., 5 sec.	125	175
Flash Point, C.O.C., °F	400	--
Solubility in Trichloroethylene, %	99.0	-
Test on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	4000
Ductility, 77F(25C), 5cm/min., cm.	75	-

SPECIFICATION
MARATHON
ASPHALT FLUX FOR RECYCLING

TEST REQUIREMENTS	MIN	MAX
Viscosity, 140F(60C), Poises	450	650
Viscosity, 275F(135C), cst	175	-
Penetration, 77F(25C), 100g., 5 sec.	150	200
Flash Point, C.O.C., °F	350	-
Solubility in Trichloroethylene, %	99.0	-
Tests on Residue from Thin Film Oven Test:		
Viscosity, 140F(60C), Poises	-	2500
Ductility, 77F(25C), 5cm/min., cm.	100	-

VI. Summary of Test Results

Test results for all twenty-eight asphalt cement samples met New York State Department of Transportation Specification requirements. The following exceptions are noted below:

A. Parco, Athens, NY
#702-0200, AC-5 Lot - Meni-Mota

Viscosity @ 140°F, Absolute	624	poises
Specification:	460 to 600	poises

B. United Refining, Warren, PA
#702-0400, AC-15 Lot 8 Canadian

Penetration @ 77°F,	57
Specification:	60 to 100

C. United Refining, Warren, PA
#702-0500, AC-20 Lot 14 Canadian

Penetration @ 77°F,	59
Specification	60 to 100

Warden Asphalt, Pittsford, NY
#702-0500, AC-20, Lot 27 Canadian

Penetration @ 77°F,	59
Specification	60 to 100

Esso Canada, Montreal, Que.
#702-0600, 85/100 Lot 1 Venezuelan Canadian

Penetration @ 77°F,	76
Specification	85 to 100

VII. Test Results

On the following pages is a tabulation of all test results. The column headed by the name of the test contains the test result determined by the Materials Bureau. The column headed by "Comparative Results" contains the test result provided by the supplier for the test indicated in the column immediately to the left.

1986 ASP		TRATION 9.2°F	COMPARATIVE RESULTS	PENETRATION RATIO 39.2°/77°F	COMPARATIVE RESULTS
MONITOR					
AC	SUPPLI	5	*	38.2	*
FLUX	CHEVRO	53	47	39.6	34.6
FLUX	CIBRO	49	49	30.8	29.3
FLUX	MARATI				
		56	48	36.2	32.0
		3.3	1.4	4.7	3.7
		53	*	32.1	*
5	PARCO	45	*	28.3	*
5	PETRO				
		49	—	30.2	—
		5.7	—	2.7	—
		38	*	33.0	*
10	PARC	32	40	33.7	43.0
10	PETRO				
		35	—	33.4	—
		4.2	—	0.5	—
		28	29	30.8	32.2
15	MARI	27	*	32.5	*
15	NOCO	26	*	30.6	*
15	PETR	30	*	34.9	*
15	SHEL	18	16	31.6	25.4
15	UNIT	18	*	28.1	*
15	WAR				
		25	23	31.4	28.8
		5.2	9.2	2.3	4.8
		28	32	35.9	39.0
20	ATLA	34	*	38.2	*
20	CHE	34	34	36.2	35.8
20	CIB	21	*	30.9	*
20	EXY	29	*	37.2	*
20	MA	23	21	32.9	29.2
20	MA	28	*	36.4	*
20	PA	29	*	37.7	*
20	PEC	23	17	39.0	26.2
20	UN	23	*	39.0	*
20	WA	32	30	42.7	37.0
20	WES				
		28	27	37.0	33.4
		4.6	7.4	3.1	5.5
		26	34	34.2	41.0
85/100	ESS	29	43	33.7	48.3
85/100	PET	29	30	34.1	35.3
85/100	SH	30	33	35.3	36.7
85/100	ULT				
		29	35	34.3	40.3
		1.7	5.6	0.7	5.8

* RESULTS NOT GIVEN

VII. Test Results

On the following pages is a tabulation of all test results. The column headed by the name of the test contains the test result determined by the Materials Bureau. The column headed by "Comparative Results" contains the test result provided by the supplier for the test indicated in the column immediately to the left.

1986 ASPHALT CEMENT MONITOR PROGRAM			ABSOLUTE VISCOSITY	COMPARATIVE	KINEMATIC VISCOSITY	COMPARATIVE	PENETRATION	COMPARATIVE	PENETRATION	COMPARATIVE	PENETRATION RATIO	COMPARATIVE
AC	SUPPLIER - LOCATION - LOT	CRUDE SOURCE	@ 140°F	RESULTS	@ 275°F	RESULTS	@ 77°F	RESULTS	@ 39.2°F	RESULTS	39.2°/77°F	RESULTS
FLUX	CHEVRON, PERTH AMBOY 18	MAYAN BOSCAN	774	735	286	278	170	170	65	*	38.2	*
FLUX	CIBRO, ALBANY 35	BOSCAN	1138	1101	334	321	134	136	53	47	39.6	34.6
FLUX	MARATHON, TONAWANDA 16	MID-CONTINENT CANADIAN	607	632	232	227	159	167	49	49	30.8	29.3
	$\bar{x}$		840	823	284	275	154	158	56	48	36.2	32.0
	σ		271.5	246.5	51.0	47.1	18.4	18.8	8.3	1.4	4.7	3.7
5	PARCO, ATHENS —	MENI-MOTA	624	658	235	228	165	161	53	*	32.1	*
5	PETRO-CAN., OAKVILLE 220	WESTERN CANADIAN	561	574	224	225	159	163	45	*	28.3	*
	$\bar{x}$		593	616	230	227	162	162	49	—	30.2	—
	σ		44.5	59.4	7.8	2.1	4.2	1.4	5.7	—	2.7	—
10	PARCO, ATHENS 16	MENI-MOTA	1139	1158	302	302	115	110	38	*	33.0	*
10	PETRO-CAN., MONTREAL 12	VENEZUELAN CANADIAN	1175	1158	307	302	95	93	32	40	33.7	43.0
	$\bar{x}$		1157	1158	305	302	105	102	35	—	33.4	—
	σ		25.5	—	3.5	—	14.1	12.0	4.2	—	0.5	—
15	MARATHON, TONAWANDA 14	MID-CONTINENT CANADIAN	1425	1447	340	338	91	90	28	29	30.8	32.2
15	NOCO ENERGY, TONAWANDA 6	WESTERN CANADIAN	1439	1546	346	*	83	70	27	*	32.5	*
15	PETRO-CAN., OAKVILLE 240	WESTERN CANADIAN	1453	1405	343	351	85	87	26	*	30.6	*
15	SHELL-CAN., HAMILTON 1	VENEZUELAN	1753	*	378	*	86	*	30	*	34.9	*
15	UNITED REF., WARREN, PA. 8	CANADIAN	1572	1470	316	315	57	63	18	16	31.6	25.4
15	WARDEN, PITTSFORD 34	CANADIAN	1510	1509	339	*	64	66	18	*	28.1	*
	$\bar{x}$		1525	1475	344	335	78	75	25	23	31.4	28.8
	σ		124.1	54.6	19.9	18.2	13.7	12.4	5.2	9.2	2.3	4.8
20	ATLANTIC, PHILADELPHIA PA. 60	MEREY, BACHAQUERO	1865	1812	373	368	78	82	28	32	35.9	39.0
20	CHEVRON, PERTH AMBOY 19	MAYAN BOSCAN	2145	1966	458	442	89	87	34	*	38.2	*
20	CIBRO, ALBANY 36	BOSCAN	1866	1779	429	410	94	95	34	34	36.2	35.8
20	EXXON, LINDEN, N.J. 21	NORTH SLOPE MAYA, MEX.	2026	1810	393	413	68	67	21	*	30.9	*
20	MANTUA, PAULSBORO, N.J. 28	WESTERN VENEZUELAN	2136	2114	407	396	78	77	29	*	37.2	*
20	MARATHON, TONAWANDA 15	MID-CONTINENT CANADIAN	2041	2077	404	390	70	72	23	21	32.9	29.2
20	PARCO, ATHENS 17	MENI-MOTA TIJUANA PESADA	1861	1864	382	388	77	82	28	*	36.4	*
20	PECKHAM, STAMFORD, CT. 28	VENEZUELAN	2114	2062	420	*	77	77	29	*	37.7	*
20	UNITED REF., WARREN, PA. 14	CANADIAN	1746	1652	377	380	59	65	23	17	39.0	26.2
20	WARDEN, PITTSFORD 27	CANADIAN	1751	1726	378	*	59	66	23	*	39.0	*
20	WEST BANK, PERTH AMBOY 8	VENEZUELAN	2138	2040	426	425	75	81	32	30	42.7	37.0
	$\bar{x}$		1972	1900	404	401	75	77	28	27	37.0	33.4
	σ		157.2	158.4	26.9	23.3	10.8	9.4	4.6	7.4	3.1	5.5
85/100	ESSO REF., MONTREAL 1	VENEZUELAN CANADIAN	1560	1492	364	364	76	83	26	34	34.2	41.0
85/100	PETRO-CAN., MONTREAL 13	VENEZUELAN CANADIAN	1275	1301	320	311	86	89	29	43	33.7	48.3
85/100	SHELL-CAN, MONTREAL 9	CANADIAN MEXICAN	1195	1161	318	302	85	85	29	30	34.1	35.3
85/100	ULTRAMAR, MONTREAL 3	VENEZUELAN	1413	1401	334	327	85	90	30	33	35.3	36.7
	$\bar{x}$		1361	1339	334	326	83	87	29	35	34.3	40.3
	σ		160.5	141.9	21.2	27.4	4.7	3.3	1.7	5.6	0.7	5.8

* RESULTS NOT GIVEN

1986 ASPH MONITOR		.T. ITY 0°F	COMPARATIVE RESULTS	T.F.O.T. VISCOSITY RATIO	COMPARATIVE RESULTS
AC	SUPPLIE	4	2431	3.18	3.31
FLUX	CHEVRO	96	3035	2.72	2.76
FLUX	CIBRO	33	1263	2.11	2.00
FLUX	MARATH				
		81	2243	2.67	2.69
		0.2	900.8	0.54	0.66
		3	1442	2.52	2.19
5	PARCO	8	1202	1.94	2.09
5	PETRO-				
		31	1322	2.23	2.14
		2.9	169.7	0.41	0.07
		21	2636	2.39	2.28
10	PARCO	66	2685	2.52	2.32
10	PETRO-				
		44	2661	2.46	2.30
		3.2	34.6	0.09	0.03
		87	3278	2.31	2.27
15	MARATH	19	*	2.38	*
15	NOCO	75	3055	1.98	2.17
15	PETRO-	14	*	2.58	*
15	SHELL-	04	3620	2.48	2.46
15	UNITED	60	*	2.75	*
15	WARDE				
		93	3318	2.41	2.30
		7.6	284.6	0.26	0.15
		491	4749	2.41	2.62
20	ATLAN	03	6014	3.08	3.06
20	CHEVR	89	5053	2.83	2.84
20	CIBRO	06	3683	2.37	2.03
20	EXXO	283	4585	2.47	2.17
20	MAN	74	4247	2.34	2.04
20	MARA	49	4484	2.50	2.41
20	PARC	87	*	2.64	*
20	PECK	02	4056	2.35	2.46
20	UNI	275	*	2.44	*
20	WAR	566	5858	3.07	2.87
20	WES				
		130	4748	2.59	2.50
		45.5	781.7	0.28	0.38
		910	*	2.51	*
85/100	ESS	415	3578	2.68	2.75
85/100	PETR	228	2998	2.70	2.58
85/100	SHEL	603	2557	2.55	1.83
85/100	ULTR				
		539	3044	2.61	2.39
		290.9	512.1	0.09	0.49

* RESULTS NOT GIVEN

1986 ASPHALT CEMENT MONITOR PROGRAM			CRUDE	T.F.O.T. LOSS	COMPARATIVE	T.F.O.T. DUCTILITY	COMPARATIVE	T.F.O.T. DUCTILITY	COMPARATIVE	T.F.O.T. VISCOSITY	COMPARATIVE	T.F.O.T. VISCOSITY	COMPARATIVE
AC	SUPPLIER-LOCATION-LOT		SOURCE	%	RESULTS	@60°F	RESULTS	@77°F	RESULTS	@140°F	RESULTS	RATIO	RESULTS
FLUX	CHEVRON, PERTH AMBOY	18	MAYAN BOSCAN	0.757	*	99	*	150+	110+	2464	2431	3.18	3.31
FLUX	CIBRO, ALBANY	35	BOSCAN	0.687	0.730	150+	150+	150+	150+	3096	3035	2.72	2.76
FLUX	MARATHON, TONAWANDA	16	MID CONTINENT CANADIAN	0.131	0.160	150+	150+	150+	150+	1283	1263	2.11	2.00
	$\bar{x}$			0.525	0.445	133	150+	150+	—	2281	2243	2.67	2.69
	σ			0.343	0.403	29.4	—	—	—	920.2	900.8	0.54	0.66
5	PARCO, ATHENS	—	MENI-MOTA	0.234	0.190	150+	*	150+	150+	1573	1442	2.52	2.19
5	PETRO-CAN., OAKVILLE	220	WESTERN CANADIAN	+0.055	+0.030	150+	*	150+	150+	1088	1202	1.94	2.09
	$\bar{x}$			0.117	0.095	150+	—	150+	150+	1331	1322	2.23	2.14
	σ			0.165	0.134	—	—	—	—	342.9	169.7	0.41	0.07
10	PARCO, ATHENS	16	MENI-MOTA	0.168	0.130	150+	*	150+	150+	2721	2636	2.39	2.28
10	PETRO-CAN., MONTREAL	12	VENEZUELAN CANADIAN	0.030	0.070	109	140+	150+	140+	2966	2685	2.52	2.32
	$\bar{x}$			0.099	0.100	130	—	150+	—	2844	2661	2.46	2.30
	σ			0.098	0.042	29.0	—	—	—	173.2	34.6	0.09	0.03
15	MARATHON, TONAWANDA	14	MID-CONTINENT CANADIAN	0.141	0.110	150+	150+	150+	150+	3287	3278	2.31	2.27
15	NOCO ENERGY, TONAWANDA	6	WESTERN CANADIAN	0.118	*	110	*	150+	*	3419	*	2.38	*
15	PETRO-CAN., OAKVILLE	240	WESTERN CANADIAN	+0.040	+0.025	150+	*	150+	150+	2875	3055	1.98	2.17
15	SHELL-CAN., HAMILTON	1	VENEZUELAN	0.259	*	78.75	*	150+	*	4514	*	2.58	*
15	UNITED REF., WARREN, PA.	8	CANADIAN	+0.010	+0.020	15.50	19	150+	120+	3904	3620	2.48	2.46
15	WARDEN, PITTSFORD	34	CANADIAN	0.364	*	14.25	*	150+	*	4160	*	2.75	*
	$\bar{x}$			0.147	0.037	86.4	84.5	150+	—	3693	3318	2.41	2.30
	σ			0.144	0.064	61.5	92.6	—	—	607.6	284.6	0.26	0.15
20	ATLANTIC, PHILADELPHIA, PA.	60	MEREY BACHAQUERO	0.019	0.025	31.50	58	150+	*	4491	4749	2.41	2.62
20	CHEVRON, PERTH AMBOY	19	MAYAN BOSCAN	0.329	*	66	*	150+	100+	6603	6014	3.08	3.06
20	CIBRO, ALBANY	36	BOSCAN	0.551	0.610	150+	148	150+	150+	5289	5053	2.83	2.84
20	EXXON, LINDEN, N.J.	21	NORTH SLOPE MAYA, MEX.	0.097	0.090	34	66	150+	150+	4806	3683	2.37	2.03
20	MANTUA, PAULSBORO, N.J.	28	WESTERN VENEZUELAN	0.174	0.200	136	*	150+	110+	5283	4585	2.47	2.17
20	MARATHON, TONAWANDA	15	MID-CONTINENT CANADIAN	0.110	0.110	92.50	150+	150+	150+	4774	4247	2.34	2.04
20	PARCO, ATHENS	17	MENI-MOTA TIJUANA PESADA	0.080	0.080	135	*	150+	150+	4649	4484	2.50	2.41
20	PECKHAM, STAMFORD, CT.	28	VENEZUELAN	0.178	*	75.25	*	150+	*	5587	*	2.64	*
20	UNITED REF., WARREN, PA.	14	CANADIAN	0.018	+0.020	50.25	45	150+	120+	4102	4056	2.35	2.46
20	WARDEN, PITTSFORD	27	CANADIAN	0.048	*	26.50	*	150+	*	4275	*	2.44	*
20	WEST BANK, PERTH AMBOY	8	VENEZUELAN	0.144	0.128	24.25	23	150+	100+	6566	5858	3.07	2.87
	$\bar{x}$			0.159	0.155	74.7	81.7	150+	—	5130	4748	2.59	2.50
	σ			0.157	0.194	47.4	54.2	—	—	845.5	781.7	0.28	0.38
85/100	ESSO REF., MONTREAL	1	VENEZUELAN CANADIAN	0.073	0.070	63.25	150+	150+	150+	3910	*	2.51	*
85/100	PETRO-CAN., MONTREAL	13	VENEZUELAN CANADIAN	0.026	0.040	76.50	95	150+	140+	3415	3578	2.68	2.75
85/100	SHELL-CAN., MONTREAL	9	CANADIAN MEXICAN	+0.041	+0.050	47.25	35	150+	80	3228	2998	2.70	2.58
85/100	ULTRAMAR, MONTREAL	3	VENEZUELAN	0.033	0.029	98.75	120	150+	150+	3603	2557	2.55	1.83
	$\bar{x}$			0.033	0.035	71.4	100.0	150+	—	3539	3044	2.61	2.39
	σ			0.030	0.029	21.8	48.8	—	—	290.9	512.1	0.09	0.49

* RESULTS NOT GIVEN

1986 ASPHA		CIFIC		C.O.C.	
MONITOR		VITY	COMPARATIVE	FLASH	COMPARATIVE
AC	SUPPLIE	7°F	RESULTS	POINT, °F	RESULTS
FLUX	CHEVRO	027	1.024	495	495
FLUX	CIBRO,	027	1.027	535	475
FLUX	MARATH	020	1.022	565	580
		025	1.024	532	517
		004	0.003	35.1	55.8
		018	1.018	530	525
5	PARCO,	017	1.019	565	608
5	PETRO-C				
		018	1.019	548	567
		.001	0.001	24.7	58.7
		.021	1.021	525	540
10	PARCO	.022	1.022	540	585
10	PETRO-				
		.022	1.022	533	563
		.001	0.001	10.6	31.8
		.026	1.024	550	580
15	MARAT	.023	*	580	*
15	NOCO	.023	1.023	590	622
15	PETRO	.019	*	545	*
15	SHELL	.024	1.022	620	615
15	UNITE	.012	*	615	*
15	WARC				
		1.021	1.023	583	606
		0.005	0.001	31.6	22.5
		1.024	1.031	545	550
20	ATLA	1.032	1.030	500	525
20	CHEV	1.030	1.030	485	485
20	CIBI	1.028	1.026	635	550+
20	EXX	1.023	1.026	535	555
20	MAN	1.028	1.028	605	600+
20	MAR	1.024	1.023	535	565
20	PAR	1.021	*	540	*
20	PECK	1.025	1.022	595	600
20	UNI	1.024	*	605	*
20	WAR	1.018	1.016	550	560
20	WE				
		1.025	1.026	557	—
		0.004	0.005	46.9	—
		1.017	1.018	610	605
85/100	ESS	1.022	1.021	560	590
85/100	PET	1.023	1.022	595	608
85/100	SHE	1.019	1.019	585	618
85/100	ULT				
		1.020	1.020	588	605
		0.003	0.002	21.0	11.6

* RESULTS NOT GIVEN

1986 ASPHALT CEMENT MONITOR PROGRAM			T.F.O.T.		T.F.O.T.		T.F.O.T.		SPECIFIC		C.O.C.	
		CRUDE	VISCOSITY	COMPARATIVE	PENETRATION	COMPARATIVE	PENETRATION	COMPARATIVE	GRAVITY	COMPARATIVE	FLASH	COMPARATIVE
AC	SUPPLIER-LOCATION-LOT	SOURCE	@ 275°F	RESULTS	@ 77°F	RESULTS	RATIO	RESULTS	@ 77°F	RESULTS	POINT, °F	RESULTS
FLUX	CHEVRON, PERTH AMBOY 18	MAYAN BOSCAN	479	*	88	*	51.8	*	1.027	1.024	495	495
FLUX	CIBRO, ALBANY 35	BOSCAN	536	528	77	75	57.5	55.1	1.027	1.027	535	475
FLUX	MARATHON, TONAWANDA 16	MID-CONTINENT CANADIAN	316	298	96	95	60.4	56.9	1.020	1.022	565	580
	$\bar{x}$		444	413	87	85	56.6	56.0	1.025	1.024	532	517
	σ		114.2	162.6	9.5	14.1	4.4	1.3	0.004	0.003	35.1	55.8
5	PARCO, ATHENS —	MENT-MOTA	336	333	91	93	55.2	57.8	1.018	1.018	530	525
5	PETRO-CAN., OAKVILLE 220	WESTERN CANADIAN	296	*	96	96	60.4	58.9	1.017	1.019	565	608
	$\bar{x}$		316	—	94	95	57.8	58.4	1.018	1.019	548	567
	σ		28.3	—	3.5	2.1	3.7	0.8	0.001	0.001	24.7	58.7
10	PARCO, ATHENS 16	MEN-MOTA	441	455	68	66	59.1	60.0	1.021	1.021	525	540
10	PETRO-CAN., MONTREAL 12	VENEZUELAN CANADIAN	449	432	58	60	61.1	64.5	1.022	1.022	540	585
	$\bar{x}$		445	444	63	63	60.1	62.3	1.022	1.022	533	563
	σ		5.7	16.3	7.1	4.2	1.4	3.2	0.001	0.001	10.6	31.8
15	MARATHON, TONAWANDA 14	MID CONTINENT CANADIAN	485	460	54	55	59.3	61.1	1.026	1.024	550	580
15	NOCO ENERGY, TONAWANDA 6	WESTERN CANADIAN	499	*	51	*	61.4	*	1.023	*	580	*
15	PETRO-CAN., OAKVILLE 240	WESTERN CANADIAN	463	*	55	54	64.7	62.1	1.023	1.023	590	622
15	SHELL-CAN., HAMILTON 1	VENEZUELAN	564	*	52	*	60.5	*	1.019	*	545	*
15	UNITED REF., WARREN, PA. 8	CANADIAN	448	430	37	36	64.9	57.1	1.024	1.022	620	615
15	WARDEN, PITTSFORD 34	CANADIAN	484	*	37	*	57.8	*	1.012	*	615	*
	$\bar{x}$		491	445	48	48	61.4	60.1	1.021	1.023	583	606
	σ		40.3	21.2	8.4	10.7	2.9	2.6	0.005	0.001	31.6	22.5
20	ATLANTIC, PHILADELPHIA, PA. 60	MEREY BACHAQUERO	544	552	51	50	65.4	61.0	1.024	1.031	545	550
20	CHEVRON, PERTH AMBOY 19	MAYAN BOSCAN	748	*	53	*	59.6	*	1.032	1.030	500	525
20	CIBRO, ALBANY 36	BOSCAN	693	662	56	54	59.6	56.8	1.030	1.030	485	485
20	EXXON, LINDEN, N.J. 21	NORTH SLOPE MAYA, MEX.	560	483	42	43	61.8	64.2	1.028	1.026	635	550+
20	MANTUA, PAULSBORO, N.J. 28	WESTERN VENEZUELAN	605	*	50	51	64.1	66.2	1.023	1.026	535	555
20	MARATHON, TONAWANDA 15	MID CONTINENT CANADIAN	573	545	44	44	62.9	61.1	1.028	1.028	605	600+
20	PARCO, ATHENS 17	MENT-MOTA TUKANA PESADA	566	538	52	51	67.5	62.2	1.024	1.023	535	565
20	PECKHAM, STAMFORD, CT. 28	VENEZUELAN	614	*	50	*	64.9	*	1.021	*	540	*
20	UNITED REF., WARREN, PA. 14	CANADIAN	531	539	44	38	74.6	58.5	1.025	1.022	595	600
20	WARDEN, PITTSFORD 27	CANADIAN	532	*	42	*	71.2	*	1.024	*	605	*
20	WEST BANK, PERTH AMBOY 8	VENEZUELAN	661	621	48	49	64.0	60.5	1.018	1.016	550	560
	$\bar{x}$		602	563	48	48	65.1	61.3	1.025	1.026	557	—
	σ		71.0	59.5	4.7	5.3	4.6	3.0	0.004	0.005	46.9	—
85/100	ESSO REF., MONTREAL 1	VENEZUELAN CANADIAN	528	*	51	50	67.1	60.2	1.017	1.018	610	605
85/100	PETRO-CAN., MONTREAL 13	VENEZUELAN CANADIAN	481	506	55	52	64.0	58.4	1.022	1.021	560	590
85/100	SHELL-CAN., MONTREAL 9	CANADIAN MEXICAN	470	448	56	57	65.9	67.1	1.023	1.022	595	608
85/100	ULTRAMAR, MONTREAL 3	VENEZUELAN	490	444	54	62	63.5	68.9	1.019	1.019	585	618
	$\bar{x}$		492	466	54	55	65.1	63.7	1.020	1.020	588	605
	σ		25.2	34.7	2.2	5.4	1.7	5.1	0.003	0.002	21.0	11.6

* RESULTS' NOT GIVEN

1986 ASPHAL		NG	COMPARATIVE	PVN	COMPARATIVE
MONITOR PR		°F	RESULTS		RESULTS
AC	SUPPLIER-		*	-0.097	-0.145
FLUX	CHEVRON,		*	-0.148	-0.194
FLUX	CIBRO, A		113	-0.538	-0.514
FLUX	MARATHON				
			113	-0.261	-0.284
		5	—	0.241	0.200
			*	-0.471	-0.552
5	PARCO, A	5	*	-0.598	-0.560
5	PETRO-CA				
		3	—	-0.535	-0.556
		8	—	0.090	0.006
		5	*	-0.495	-0.547
10	PARCO,	5	115	-0.684	-0.732
10	PETRO-C				
		5	—	-0.590	-0.640
		—	—	0.134	0.131
		7	117	-0.576	-0.597
15	MARATHO	6	*	-0.650	*
15	NOCO EN	6	*	-0.637	-0.578
15	PETRO-C	9	*	-0.479	*
15	SHELL- C	25	125	-1.150	-1.061
15	UNITED	24	*	-0.943	*
15	WARDEN				
		20	121	-0.739	-0.745
		.0	5.7	0.254	0.274
		20	*	-0.605	-0.571
20	ATLANT	21	*	-0.152	-0.232
20	CHEVRO	19	*	-0.187	-0.244
20	CIBRO	22	*	-0.672	-0.616
20	EXXON	22	*	-0.476	-0.531
20	MANTU	22	120	-0.602	-0.624
20	MARAT	20	*	-0.583	-0.493
20	PARCO	20	*	-0.444	*
20	PECKHA	25	122	-0.871	-0.765
20	UNITE	22	*	-0.868	*
20	WARDE	22	112	-0.452	-0.371
20	WEST				
		21	118	-0.537	-0.494
		1.6	5.3	0.233	0.180
		18	112	-0.668	-0.574
85/100	ESSO	18	115	-0.728	-0.735
85/100	PETRO	18	119	-0.750	-0.827
85/100	SHELL	17	118	-0.677	-0.647
85/100	ULTRA				
		18	116	-0.706	-0.696
		.50	3.2	0.040	0.109

* RESULTS NOT GIVEN

1986 ASPHALT CEMENT MONITOR PROGRAM												
AC	SUPPLIER-LOCATION- LOT	CRUDE SOURCE	DUCTILITY @ 39.2°F	COMPARATIVE RESULTS	DUCTILITY @ 77°F	COMPARATIVE RESULTS	SOLUBILITY %	COMPARATIVE RESULTS	SOFTENING POINT, °F	COMPARATIVE RESULTS	PVN	COMPARATIVE RESULTS
FLUX	CHEVRON, PERTH AMBOY 18	MAYAN BOSCAN	150+	*	150+	*	99.98	99.93	114	*	-0.097	-0.145
FLUX	CIBRO, ALBANY 35	BOSCAN	150+	*	150+	150+	99.99	99.98	111	*	-0.148	-0.194
FLUX	MARATHON, TONAWANDA 16	MID-CONTINENT CANADIAN	150+	110+	150+	150+	99.98	99.98	109	113	-0.538	-0.514
	$\bar{X}$		150+	110+	150+	150+	99.98	99.96	111	113	-0.261	-0.284
	σ		—	—	—	—	0.01	0.03	2.5	—	0.241	0.200
5	PARCO, ATHENS —	MENI-MOTA	150+	*	150+	150+	99.99	99.99	110	*	-0.471	-0.552
5	PETRO-CAN., OAKVILLE 220	WESTERN CANADIAN	150+	150+	150+	—	99.99	99.95	106	*	-0.598	-0.560
	$\bar{X}$		150+	—	150+	—	99.99	99.97	108	—	-0.535	-0.556
	σ		—	—	—	—	—	0.03	2.8	—	0.090	0.006
10	PARCO, ATHENS 16	MENI-MOTA	150+	*	150+	150+	99.99	99.98	115	*	-0.495	-0.547
10	PETRO-CAN., MONTREAL 12	VENEZUELAN CANADIAN	76.50	30+	150+	140+	99.99	99.91	115	115	-0.684	-0.732
	$\bar{X}$		113.3	—	150+	—	99.99	99.95	115	—	-0.590	-0.640
	σ		52.0	—	—	—	—	0.05	—	—	0.134	0.131
15	MARATHON, TONAWANDA 14	MID-CONTINENT CANADIAN	83.50	110+	150+	150+	99.98	99.98	117	117	-0.576	-0.597
15	NOCO ENERGY, TONAWANDA 6	WESTERN CANADIAN	28.50	*	150+	*	99.97	*	116	*	-0.650	*
15	PETRO-CAN., OAKVILLE 240	WESTERN CANADIAN	53.75	24.8	150+	*	99.99	99.96	116	*	-0.637	-0.578
15	SHELL-CAN, HAMILTON 1	VENEZUELAN	63.75	*	150+	*	99.99	*	119	*	-0.479	*
15	UNITED REF., WARREN, PA. 8	CANADIAN	5.25	*	150+	120+	99.24	99.50	125	125	-1.150	-1.061
15	WARDEN, PITTSFORD 34	CANADIAN	5.50	*	150+	*	99.31	*	124	*	-0.943	*
	$\bar{X}$		40.0	—	150+	—	99.75	99.81	120	121	-0.739	-0.745
	σ		32.2	—	—	—	0.37	0.27	4.0	5.7	0.254	0.274
20	ATLANTIC, PHILADELPHIA, PA. 60	MEREY BACHAQUERO	33.75	*	150+	*	99.99	99.94	120	*	-0.605	-0.571
20	CHEVRON, PERTH AMBOY 19	MAYAN BOSCAN	21.50	*	150+	*	99.97	99.95	121	*	-0.152	-0.232
20	CIBRO, ALBANY 36	BOSCAN	150+	*	150+	150+	99.96	99.96	119	*	-0.187	-0.244
20	EXXON, LINDEN, N.J. 21	NORTH SLOPE MAYA, MEX.	11.25	*	150+	150+	99.99	99.99	122	*	-0.672	-0.616
20	MANTUA, PAULSBORO, N.J. 28	WESTERN VENEZUELAN	150+	*	150+	*	99.99	99.97	122	*	-0.476	-0.531
20	MARATHON, TONAWANDA 15	MID-CONTINENT CANADIAN	15.25	38	150+	150+	99.99	99.97	122	120	-0.602	-0.624
20	PARCO, ATHENS 17	MENI-MOTA TIJUANA PESADA	93.0	*	150+	150+	99.98	99.98	120	*	-0.583	-0.493
20	PECKHAM, STAMFORD, CT. 28	VENEZUELAN	45.25	*	150+	*	99.99	*	120	*	-0.444	*
20	UNITED REF., WARREN, PA. 14	CANADIAN	9.25	*	150+	120+	99.78	99.50	125	122	-0.871	-0.765
20	WARDEN, PITTSFORD 27	CANADIAN	9.50	*	150+	*	99.76	*	122	*	-0.868	*
20	WEST BANK, PERTH AMBOY 8	VENEZUELAN	17.75	44	150+	100+	99.98	99.95	122	112	-0.452	-0.371
	$\bar{X}$		50.6	41	150+	—	99.94	99.91	121	118	-0.537	-0.494
	σ		54.8	4.2	—	—	0.09	0.16	1.6	5.3	0.233	0.180
85/100	ESSO REF., MONTREAL 1	VENEZUELAN CANADIAN	17.50	11	150+	150+	99.98	99.97	118	112	-0.668	-0.574
85/100	PETRO-CAN., MONTREAL 13	VENEZUELAN CANADIAN	57.25	30+	150+	140+	99.97	99.96	118	115	-0.728	-0.735
85/100	SHELL-CAN., MONTREAL 9	CANADIAN MEXICAN	17.25	10	150+	150+	99.90	99.70	118	119	-0.750	-0.827
85/100	ULTRAMAR, MONTREAL 3	VENEZUELAN	57.0	34	150+	150+	99.99	99.99	117	118	-0.677	-0.647
	$\bar{X}$		37.3	—	150+	—	99.96	99.91	118	116	-0.706	-0.696
	σ		23.0	—	—	—	0.04	0.14	0.50	3.2	0.040	0.109

* RESULTS NOT GIVEN

1986 ASPHALT
MONITORING
AC SUPPLIEMATICS

FLUX	CHEVRO	0.22
FLUX	CIBRO	2.03
FLUX	MARATH	1.70
		1.32
		0.96
		5.91
5	PARCO	3.62
5	PETRO	
		7.27
		1.92
		7.76
10	PARCO	7.35
10	PETRO	
		7.56
		0.29
		2.87
15	MARA	1.20
15	NOCO	2.10
15	PETRO	8.72
15	SHEL	8.57
15	UNITE	9.78
15	WARD	
		0.54
		1.79
		4.09
20	ATLAN	7.75
20	CHEV	0.92
20	CIBA	8.71
20	EXXO	4.69
20	MAN	5.42
20	MAR	7.45
20	PAR	7.05
20	PECK	1.88
20	UNIT	2.44
20	WAR	9.25
20	WES	
		39.97
		3.27
		7.73
85/100	ESSO	7.70
85/100	PETRO	7.16
85/100	SHEL	9.20
85/100	ULTR	
		37.95
		0.88

* RESULTS NOT GIVEN

1986 ASPHALT CEMENT MONITOR PROGRAM					SETTLEMENT TEST			%	%			
AC	SUPPLIER - LOCATION - LOT	CRUDE SOURCE	PIN	COMPARATIVE RESULTS	MINUTES	ASPHALTENES %	SATURATES %	NAPHTHENE AROMATICS	POLAR AROMATICS			
FLUX	CHEVRON, PERTH AMBOY 18	MAYAN BOSCAN	+1.380	*	27.3	17.11	9.70	25.33	40.22			
FLUX	CIBRO, ALBANY 35	BOSCAN	−0.177	*	28.3	15.91	8.64	25.03	42.03			
FLUX	MARATHON, TONAWANDA 16	MID-CONTINENT CANADIAN	+0.089	+1.107	56.3	10.90	10.29	29.30	41.70			
	$\bar{x}$		0.431	—	37.3	14.64	9.54	26.55	41.32			
	σ		0.833	—	16.5	3.29	0.84	2.38	0.96			
5	PARCO, ATHENS —	MENI-MOTA	+0.454	*	74.8	13.63	13.44	29.56	35.91			
5	PETRO-CAN., OAKVILLE 220	WESTERN CANADIAN	−0.559	*	30.9	10.84	11.98	32.01	38.62			
	$\bar{x}$		−0.053	—	52.9	12.24	12.71	30.79	37.27			
	σ		0.716	—	31.0	1.97	1.03	1.73	1.92			
10	PARCO, ATHENS 16	MENI-MOTA	+0.016	*	79.0	11.31	18.15	23.91	37.76			
10	PETRO-CAN., MONTREAL 12	VENEZUELAN CANADIAN	−0.600	−0.665	43.8	14.09	12.26	31.94	37.35			
	$\bar{x}$		−0.292	—	61.4	12.70	15.21	27.93	37.56			
	σ		0.436	—	24.9	1.97	4.16	5.68	0.29			
15	MARATHON, TONAWANDA 14	MID-CONTINENT CANADIAN	−0.397	−0.430	42.6	12.39	8.92	28.61	42.87			
15	NOCO ENERGY, TONAWANDA 6	WESTERN CANADIAN	−0.828	*	29.7	12.00	8.75	28.69	41.20			
15	PETRO-CAN., OAKVILLE 240	WESTERN CANADIAN	−0.761	*	31.3	12.25	9.26	28.93	42.10			
15	SHELL-CAN., HAMILTON 1	VENEZUELAN	−0.246	*	105.9	12.09	11.08	32.68	38.72			
15	UNITED REF., WARREN, PA. 8	CANADIAN	−0.479	−0.227	54.7	12.18	10.15	33.82	38.57			
15	WARDEN, PITTSFORD 34	CANADIAN	−0.324	*	66.4	9.03	8.40	34.15	39.78			
	$\bar{x}$		−0.506	−0.329	55.1	11.66	9.43	31.15	40.54			
	σ		0.238	0.144	28.6	1.29	1.01	2.68	1.79			
20	ATLANTIC, PHILADELPHIA, PA. 60	MEREY BACHAQUERO	−0.372	*	72.6	8.36	11.00	28.97	44.09			
20	CHEVRON, PERTH AMBOY 19	MAYAN BOSCAN	+0.167	*	18.6	19.50	16.12	18.88	37.75			
20	CIBRO, ALBANY 36	BOSCAN	+0.024	*	28.3	16.78	18.43	15.02	40.92			
20	EXXON, LINDEN, N.J. 21	NORTH SLOPE MAYA, MEX.	−0.449	*	39.5	15.14	9.37	31.68	38.71			
20	MANTUA, PAULSBORO, N.J. 28	WESTERN VENEZUELAN	−0.073	*	114.5	13.52	10.71	32.05	34.69			
20	MARATHON, TONAWANDA 15	MID-CONTINENT CANADIAN	−0.372	−0.592	41.8	12.59	7.64	27.37	45.42			
20	PARCO, ATHENS 17	MENI-MOTA TUJANA PESADA	−0.408	*	67.3	14.43	10.15	27.98	37.45			
20	PECKHAM, STAMFORD, CT. 28	VENEZUELAN	−0.408	*	71.4	14.78	11.31	28.69	37.05			
20	UNITED REF., WARREN, PA. 14	CANADIAN	−0.394	−0.567	24.4	13.87	10.30	26.43	41.88			
20	WARDEN, PITTSFORD 27	CANADIAN	−0.810	*	24.9	12.69	9.22	27.07	42.44			
20	WEST BANK, PERTH AMBOY 8	VENEZUELAN	−0.183	−1.567	91.7	13.22	10.41	28.48	39.25			
	$\bar{x}$		−0.298	−0.909	54.1	14.08	11.33	26.60	39.97			
	σ		0.267	0.570	31.5	2.76	3.15	5.15	3.27			
85/100	ESSO REF., MONTREAL 1	VENEZUELAN CANADIAN	−0.752	−1.502	84.4	14.97	9.33	29.24	37.73			
85/100	PETRO-CAN., MONTREAL 13	VENEZUELAN CANADIAN	−0.404	−0.794	40.4	14.58	11.43	28.69	37.70			
85/100	SHELL-CAN., MONTREAL 9	CANADIAN MEXICAN	−0.438	−0.280	22.0	14.77	11.71	27.30	37.16			
85/100	ULTRAMAR, MONTREAL 3	VENEZUELAN	−0.598	−0.269	67.9	12.58	21.19	17.31	39.20			
	$\bar{x}$		−0.548	−0.711	53.7	14.23	13.42	25.64	37.95			
	σ		0.160	0.581	27.8	1.11	5.29	5.61	0.88			

* RESULTS NOT GIVEN

Three suppliers submitted Asphalt Composition Analysis Results to the Materials Bureau.

A. Petro-Canada, Montreal, Quebec
#702-0300, AC-10 Lot 12 Venezuelan Canadian

Asphalt Composition Analysis

	Materials Bureau	Petro Canada
% Asphaltenes,	14.09	16.5
% Saturates,	12.26	19.1
% Naphthene Aromatics,	31.94	37.7
% Polar Aromatics,	37.35	26.7

Petro-Canada, Montreal, Que
#702-0600, 85/100 Lot 13 Venezuelan Canadian

Asphalt Composition Analysis

	Materials Bureau	Petro Canada
% Asphaltenes	14.58	16.9
% Saturates	11.43	20.1
% Naphthene Aromatics	28.69	35.4
% Polar Aromatics	37.70	27.6

B. Shell Canada, Montreal, Que.
#702-0600, 85/100 Lot 9 Canadian, Mexican

Asphalt Composition Analysis

	Materials Bureau	Shell-Canada
%Asphaltenes	14.77	14.1
% Saturates	11.71	15.5
% Aromatics	-	50.9
% Resins	-	19.5

C. Ultramar, Montreal, Que.
#702-0600, 85/100 Lot 3 Venezuelan

	Materials Bureau	Ultramar
% Asphaltenes	12.58	29.02

VIII. Statistical Analysis of Test Results

The mean, range and standard deviation were determined for the number of samples tested in each grade of asphalt cement. For each test, this statistical information has been determined separately for the Materials Bureau results and when applicable, the comparable results submitted by the supplier.

A. ABSOLUTE VISCOSITY @ 140°F (POISES)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	840	593	1157	1525	1972	1361
Range	607 to 1138	561 to 624	1139 to 1175	1425 to 1753	1746 to 2145	1195 to 1560
Standard Deviation	271.5	44.5	25.5	124.1	157.2	160.5

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	5	11	4
Mean	823	616	1158	1475	1900	1339
Range	632 to 1101	574 to 658	-	1405 to 1546	1652 to 2114	1161 to 1492
Standard Deviation	246.5	59.4	-	54.6	158.4	141.9

B. KINEMATIC VISCOSITY @ 275°F (CENTISTOKES)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	284	230	305	344	404	334
Range	232 to 334	224 to 235	302 to 307	316 to 378	373 to 458	318 to 364
Standard Deviation	51.0	7.8	3.5	19.9	26.9	21.2

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	3	9	4
Mean	275	227	302	335	401	326
Range	227 to 321	225 to 228	-	315 to 351	368 to 442	302 to 364
Standard Deviation	47.1	2.1	-	18.2	23.3	27.4

C. PENETRATION @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	154	162	105	78	75	83
Range	134 to 170	159 to 165	95 to 115	57 to 91	59 to 94	76 to 86
Standard Deviation	18.4	4.2	14.1	13.7	10.8	4.7

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	158	162	102	75	77	87
Range	136 to 170	161 to 163	93 to 110	63 to 90	65 to 95	83 to 90
Standard Deviation	18.8	1.4	12.0	12.4	9.4	3.3

D. PENETRATION @ 39.2°F

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	56	49	35	25	28	29
Range	49 to 65	45 to 53	32 to 38	18 to 30	21 to 34	26 to 30
Standard Deviation	8.3	5.7	4.2	5.2	4.6	1.7

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	2	-	1	2	5	4
Mean	48	-	-	23	27	35
Range	47to 49	-	-	16 to 29	17 to 34	30 to 43
Standard Deviation	1.4	-	-	9.2	7.4	5.6

E. PENETRATION RATIO

(PENETRATION @ 39.2°F divided by PENETRATION @ 77°F) X 100

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	36.2	30.2	33.4	31.4	37.0	34.3
Range	30.8 to 39.6	28.3 to 32.1	33.0 to 33.7	28.1 to 34.9	30.9 to 42.7	33.7 to 35.3
Standard Deviation	4.7	2.7	0.5	2.3	3.1	0.7

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	2	0	1	2	5	4
Mean	32.0	-	-	28.8	33.4	40.3
Range	29.3 to 34.6	-	-	25.4 to 32.2	26.2 to 39.0	35.3 to 48.3
Standard Deviation	3.7	-	-	4.8	5.5	5.8

-

F. THIN FILM OVEN TEST, % LOSS

(SAMPLES WHICH SHOWED WEIGHT GAINS WERE CALCULATED AS 0.000% LOSS)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	26	6	11	4
Mean	0.525	0.117	0.099	0.147	0.159	0.033
Range	0.131 to 0.757	0.000 to 0.234	0.030 to 0.168	0.000 to 0.364	0.018 to 0.551	0.000 to 0.073
Standard Deviation	0.343	0.165	0.098	0.144	0.157	0.030

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	2	2	2	3	8	4
Mean	0.445	0.095	0.100	0.037	0.155	0.035
Range	0.160 to 0.730	0.000 to 0.190	0.070 to 0.130	0.000 to 0.110	0.000 to 0.610	0.000 to 0.070
Standard Deviation	0.403	0.134	0.042	0.064	0.194	0.029

G. THIN FILM OVEN TEST, DUCTILITY @ 60°F, 5cm/min. (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	133	150+	130	86.4	74.7	71.4
Range	99 to 150+	-	109 to 150+	14.25 to 150+	24.25 to 150+	47.25 to 98.75
Standard Deviation	29.4	-	29.0	61.5	47.4	21.8

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	2	0	1	2	6	4
Mean	150+	-	-	84.5	81.7	100.0
Range	-	-	-	19 to 150+	23.0 to 150+	35 to 150+
Standard Deviation	-	-	-	92.6	54.2	48.8

H. THIN FILM OVEN TEST, DUCTILITY @ 77°F, 5cm/min. (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	150+	150+	150+	150.0+	150+	150+
Range	-	-	-	-	-	-
Standard Deviation	-	-	-	-	-	-

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	3	8	4
Mean	-	150+	-	-	-	-
Range	110+ to 150+	-	140+ to 150+	120+ to 150+	100+ to 150+	80 to 150+
Standard Deviation	-	-	-	-	-	-

I. THIN FILM OVEN TEST, ABSOLUTE VISCOSITY @ 140°F, (POISES)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	2281	1331	2844	3693	5130	3539
Range	1283 to 3096	1088 to 1573	2721 tp 2966	2875 to 4514	4102 to 6603	3228 to 3910
Standard Deviation	920.2	342.9	173.2	607.6	845.5	290.9

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	3	9	3
Mean	2243	1322	2661	3318	4748	3044
Range	1263 to 3035	1202 to 1442	2636 to 2685	3055 to 3620	3683 to 6014	2557 to 3578
Standard Deviation	900.8	169.7	34.6	284.6	781.7	512.1

J. ABSOLUTE VISCOSITY @140°F RATIO

(AFTER T.F.O.T. VISCOSITY @ 140°F DIVIDED BY ORIGINAL VISCOSITY @ 140°F)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	2.67	2.23	2.46	2.41	2.59	2.61
Range	2.11 to 3.18	1.94 to 2.52	2.39 to 2.52	1.98 to 2.75	2.34 to 3.08	2.51 to 2.70
Standard Deviation	0.54	0.41	0.09	0.26	0.28	0.09

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	3	9	3
Mean	2.69	2.14	2.30	2.30	2.50	2.39
Range	2.00 to 3.31	2.09 to 2.19	2.28 to 2.32	2.17 to 2.46	2.04 to 3.06	1.83 to 2.75
Standard Deviation	0.66	0.07	0.03	0.15	0.38	0.49

K. THIN FILM OVEN TEST, KINEMATIC VISCOSITY @ 275°F, (CENTISTOKES)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	444	316	445	491	602	492
Range	316 to 536	296 to 336	441 to 449	448 to 564	531 to 748	470 to 528
Standard Deviation	114.2	28.3	5.7	40.3	71.0	25.2

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	2	1	2	2	7	3
Mean	413	-	444	445	563	466
Range	298 to 528	-	432 to 455	430 to 460	483 to 662	444 to 506
Standard Deviation	162.6	-	16.3	21.2	59.5	34.7

L. THIN FILM OVEN TEST, PENETRATION @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	87	94	63	48	48	54
Range	77 to 96	91 to 96	58 to 68	37 to 55	42 to 56	51 to 56
Standard Deviation	9.5	3.5	7.1	8.4	4.7	2.2

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	2	2	2	3	8	4
Mean	85	95	63	48	48	55
Range	75 to 95	93 to 96	60 to 66	36 to 55	38 to 54	50 to 62
Standard Deviation	14.1	2.1	4.2	10.7	5.3	5.4

M. PENETRATION @ 77°F RATIO,

(AFTER T.F.O.T. PENETRATION @77°F DIVIDED BY ORIGINAL PENETRATION @ 77°F) X 100

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	56.6	57.8	60.1	61.4	65.1	65.1
Range	51.8 to 60.4	55.2 to 60.4	59.1 to 61.1	57.8 to 64.9	59.6 to 74.6	63.5 to 67.1
Standard Deviation	4.4	3.7	1.4	2.9	4.6	1.7

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	2	2	2	3	4	4
Mean	56.0	58.4	62.3	60.1	61.3	63.7
Range	55.1 to 56.9	57.8 to 58.9	60.0 to 64.5	57.1 to 62.1	56.8 to 62.2	58.4 to 68.9
Standard Deviation	1.3	0.8	3.2	2.6	3.0	5.1

N. SPECIFIC GRAVITY @ 77°F

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	1.025	1.018	1.022	1.021	1.025	1.020
Range	1.020 to 1.027	1.017 to 1.018	1.021 to 1.022	1.012 to 1.026	1.018 to 1.032	1.017 to 1.023
Standard Deviation	0.004	0.001	0.001	0.005	0.004	0.003

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	3	9	4
Mean	1.024	1.019	1.022	1.023	1.026	1.020
Range	1.022 to 1.027	1.018 to 1.019	1.021 to 1.022	1.022 to 1.024	1.016 to 1.031	1.018 to 1.022
Standard Deviation	0.003	0.001	0.001	0.001	0.005	0.002

O. FLASH POINT, CLEVLAND OPEN CUP, °F

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	532	548	533	583	557	588
Range	495 to 565	530 to 565	525 to 540	545 to 620	485 to 635	560 to 610
Standard Deviation	35.1	24.7	10.6	31.6	46.9	21.0

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	3	9	4
Mean	517	567	563	606	-	605
605 Range	475 to 580	525 to 608	540 to 585	580 to 622	485 to 600+	590 to 618
Standard Deviation	55.8	58.7	31.83	22.5	-	11.6

P. DUCTILITY @ 39.2°F, 1cm/min., ORIGINAL SAMPLE (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	150.0+	150+	113.3	40.0	50.6	37.3
Range	-	-	76.5 to 150+	5.25 to 83.50	9.25 to 150+	17.25 to 57.25
Standard Deviation	-	-	52.0	32.2	54.8	23.0

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	1	1	1	2	2	4
Mean	-	-	-	-	41	-
Range	-	-	-	24.8 to 110+	38 to 44	10 to 30+
Standard Deviation	-	-	-	-	4.2-	-

Q. DUCTILITY @ 77°F, 5cm/min., ORIGINAL SAMPLE (CENTIMETERS)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	150.0+	150+	150+	150.0+	150.0+	150.0+
Range	-	-	-	-	-	-
Standard Deviation	-	-	-	-	-	-

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	2	1	2	2	6	4
Mean	150+	-	-	-	-	-
Range	-	-	140+ to 150+	120+ to 150+	100+ to 150+	140+ to 150+
Standard Deviation	-	-	-	-	-	-

R. SOLUBILITY IN TRICHLOROETHYLENE, (%)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	99.98	99.99	99.99	99.75	99.94	99.96
Range	99.98 to 99.99	-	-	99.24 to 99.99	99.76 to 99.99	99.90 to 99.99
Standard Deviation	0.01	-	-	0.37	0.09	0.04

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	3	9	4
Mean	99.96	99.97	99.95	99.81	99.91	99.91
Range	99.93 to 99.98	99.95 to 99.99	99.91 to 99.98	99.50 to 99.98	99.50 to 99.99	99.70 to 99.99
Standard Deviation	0.03	0.03	0.05	0.27	0.16	0.14

S. SOFTENING POINT, IN ETHYLENE GLYCOL, (°F)

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	111	108	115	120	121	118
Range	109 to 114	106 to 110	-	116 to 125	119 to 125	117 to 118
Standard Deviation	2.5	2.8	-	4.0	1.6	0.50

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	1	-	1	6	3	4
Mean	-	-	-	121	118	116
Range	-	-	-	117 to 125	112 to 122	112 to 119
Standard Deviation	-	-	-	5.7	5.3	3.2

T. Penetration Viscosity Number, (PVN)

The penetration viscosity number, PVN, is an indicator of the temperature susceptibility of asphalt cements. Lower PVN indicates greater temperature susceptibility. It is suggested that an asphalt cement with a PVN less than -0.5 is temperature susceptible.

$$PVN = \frac{\text{Log } A - \text{Log } V}{\text{Log } A - \text{Log } B} \times (-1.5)$$

Where Log A = 4.25800 - 0.79674 Log (Penetration @ 77°F)
Log B = 3.46289 - 0.61094 Log (Penetration @ 77°F)
Log V = Log (Viscosity @ 275°F, Kinematic)

The results indicate that most of these asphalt cements are temperature susceptible by PVN criteria.

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	-0.261	-0.535	-0.590	-0.739	-0.537	-0.706
Range	-0.097 to -0.538	-0.471 to -0.598	-0.495 to -0.684	-0.479 to -1.150	-0.152 to -0.871	-0.668 to -0.750
Standard Deviation	0.241	0.090	0.134	0.254	0.233	0.040

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	3	9	4
Mean	-0.284	-0.556	-0.640	-0.745	-0.494	-0.696
Range	-0.145 to -0.514	-0.552 to -0.560	-0.547 to -0.732	-0.578 to -1.061	-0.232 to -0.765	-0.574 to -0.827
Standard Deviation	0.200	0.006	0.131	0.274	0.180	0.109

U. Penetration Index Numbers, (PIN)

The penetration Index Number is another indicator of temperature susceptibility of asphalt cements. Large negative values of PIN indicate greater temperature susceptibility. "Typical" asphalts have values between +2 and -2.

$$PIN = \frac{30}{1 + 90\ PTS} - 10$$

PTS = Penetration Temperature Susceptibility

$$PTS = \frac{\text{Log } 800 - \text{Log (Penetration @ } 77°F)}{\text{Softening Point } (°F) - 77°F}$$

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	0.431	-0.053	-0.292	-0.506	-0.298	-0.548
Range	+1.380 to -0.177	+0.454 to -0.559	+0.016 to -0.600	-0.246 to -0.828	+0.167 to -0.810	-0.404 to -0.[illegible]
Standard Deviation	0.833	0.716	0.436	0.238	0.267	0.160

2. Comparative Results

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	1	0	1	2	3	4
Mean	-	-	-	-0.329	-0.909	-0.711
Range	-	-	-	-0.227 to -0.430	-0.567 to -1.567	-0.269 to -1.[illegible]
Standard Deviation	-	-	-	0.144	0.570	0.581

V. A Settling Test to Evaluate The Relative Degree of Dispersion of Asphaltenes

by

H. Plancher)
J. C. Petersen)
Laramie Energy Technology Center
U.S. Department of Energy
P.O. Box 3395
Laramie, Wyoming 82071

A. J. Hoiberg)
S. C. Suhaka)
Johns - Manville Sales Corporation
R&D Center
Ken - Caryl Ranch
Denver, Colorado 80217

The asphaltene settling test is used to evaluate the relative degree of dispersion of asphaltenes from paving asphalts. This test distinguishes differences in asphaltene settling times of asphalts in their hexane-maltene solutions. The test involves digesting asphalt in n-hexane, transferring the contents into a graduated cylinder and measuring the time required for the asphaltene meniscus to settle to the 25 ml. mark of a 50 ml. cylinder. Slower settling times indicate a greater degree of dispersion of the asphaltenes and thus a more compatible asphalt, which in turn is considered to be an important property that contributes to asphalt durability. The test is extremely sensitive to changes in asphalt composition. Time is reported in minutes.

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	37.3	52.9	61.4	55.1	54.1	53.7
Range	27.3 to 56.3	30.9 to 74.8	43.8 to 79.0	29.7 to 105.9	18.6 to 114.5	22.0 to 84.4
Standard Deviation	16.5	31.0	24.9	28.6	31.5	27.8

W. Separation of Asphalt Into Four Fractions; Modified Method of ASTM D 4124-84, Section 4, Volume 04.03

The purpose is to separate the four generic fractions present in asphalt. These fractions are saturates, naphthene aromatics, polar aromatics, and asphaltenes. The relative amount of each fraction plays a role in determining the physical properties of the asphalt. These properties include viscosity, ductility, softening point and temperature susceptibility.

The procedure follows:

The percent asphaltene is determined by dispersing the asphalt in n-heptane and refluxing. The insolubles are the asphaltenes.

The remaining three fractions are determined by absorbing the deasphaltened n-heptane solution on a calcined alumina chromatography column and eluting (removing) each fraction with a different solvent. Saturates are eluted with n-heptane. Naphthene aromatics are eluted with toluene. Polar Aromatics are eluted with 50/50 toluene - methanol solution, followed by trichloroethylene. The solvents are then evaporated and weight percentages of each fraction with respect to the original asphalt sample are determined.

ASPHALTENES, %

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	14.64	12.24	12.70	11.66	14.08	14.23
Range	10.90 to 17.11	10.84 to 13.63	11.31 to 14.09	9.03 to 12.39	8.36 to 19.50	12.58 to 14
Standard Deviation	3.29	1.97	1.97	1.29	2.76	1.11

SATURATES, %

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	9.54	12.71	15.21	9.43	11.33	13.42
Range	8.64 to 10.29	11.98 to 13.44	12.26 to 18.15	8.40 to 11.08	7.64 to 18.43	9.33 to 21.[illegible]
Standard Deviation	0.84	1.03	4.16	1.01	3.15	5.29

NAPHTHENE - AROMATICS, %

1. Materials Bureau

	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	26.55	30.79	27.93	31.15	26.60	25.64
Range	25.03 to 29.30	29.56 to 32.01	23.91 to 31.94	28.61 to 34.15	15.02 to 32.05	17.31 to 29.24
Standard Deviation	2.38	1.73	5.68	2.68	5.15	5.61

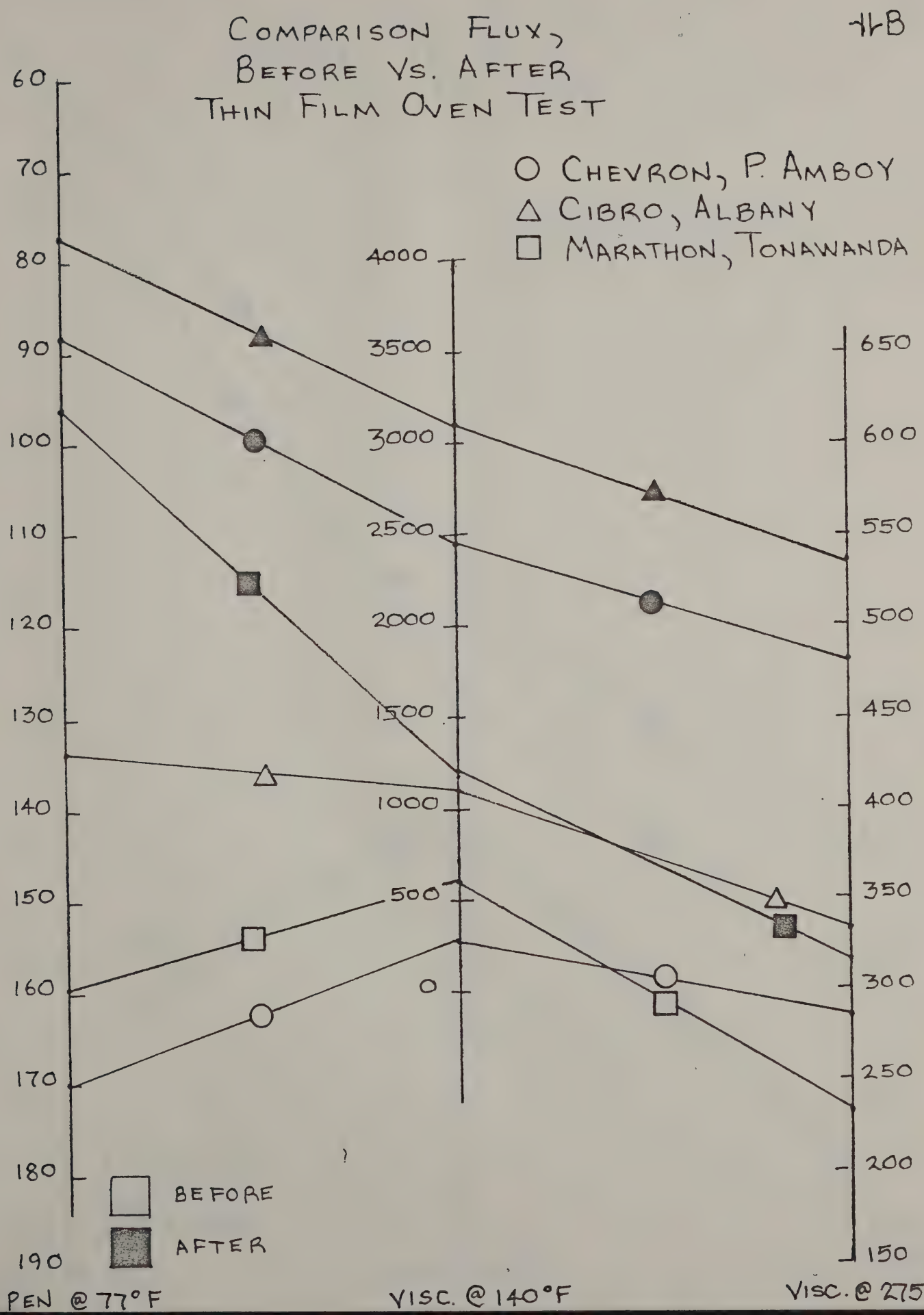
POLAR AROMATICS, %

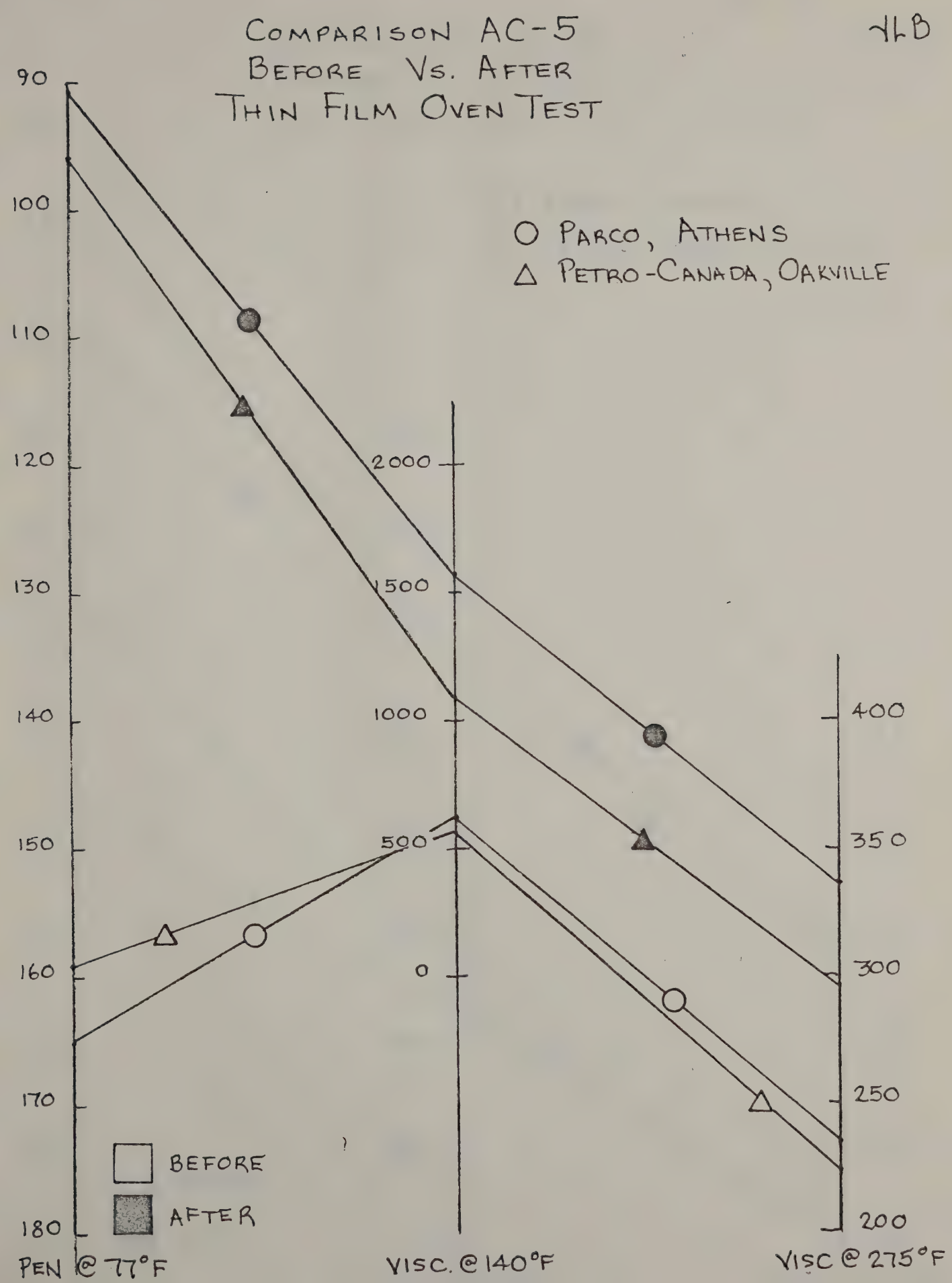
1. Materials Bureau

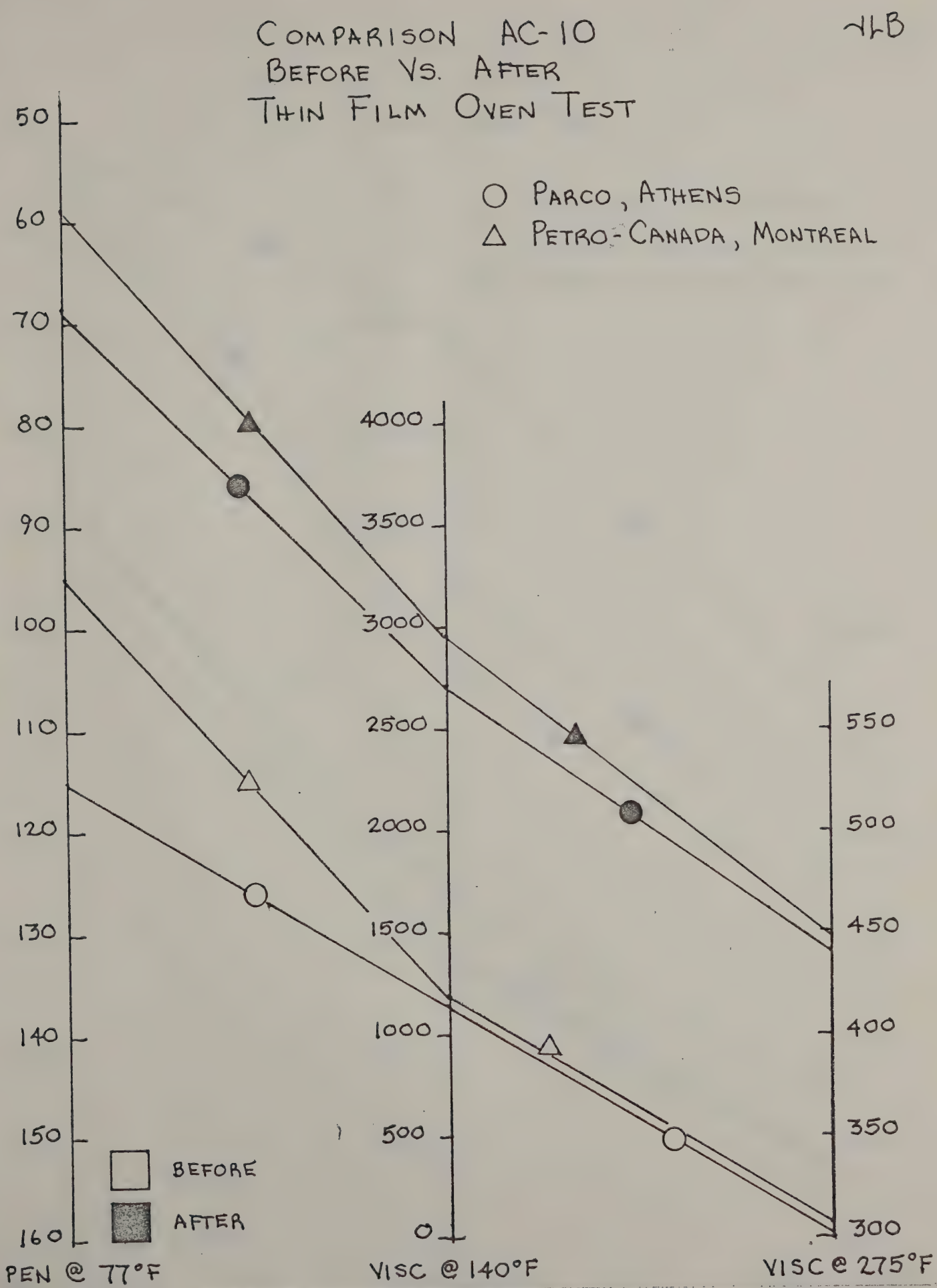
	FLUX	AC-5	AC-10	AC-15	AC-20	85/100
Number of Samples	3	2	2	6	11	4
Mean	41.32	37.27	37.56	40.54	39.97	37.95
Range	41.70 to 42.03	35.91 to 38.62	37.35 to 37.76	38.57 to 42.87	34.69 to 45.42	37.16 to 39.20
Standard Deviation	0.96	1.92	0.29	1.79	3.27	0.88

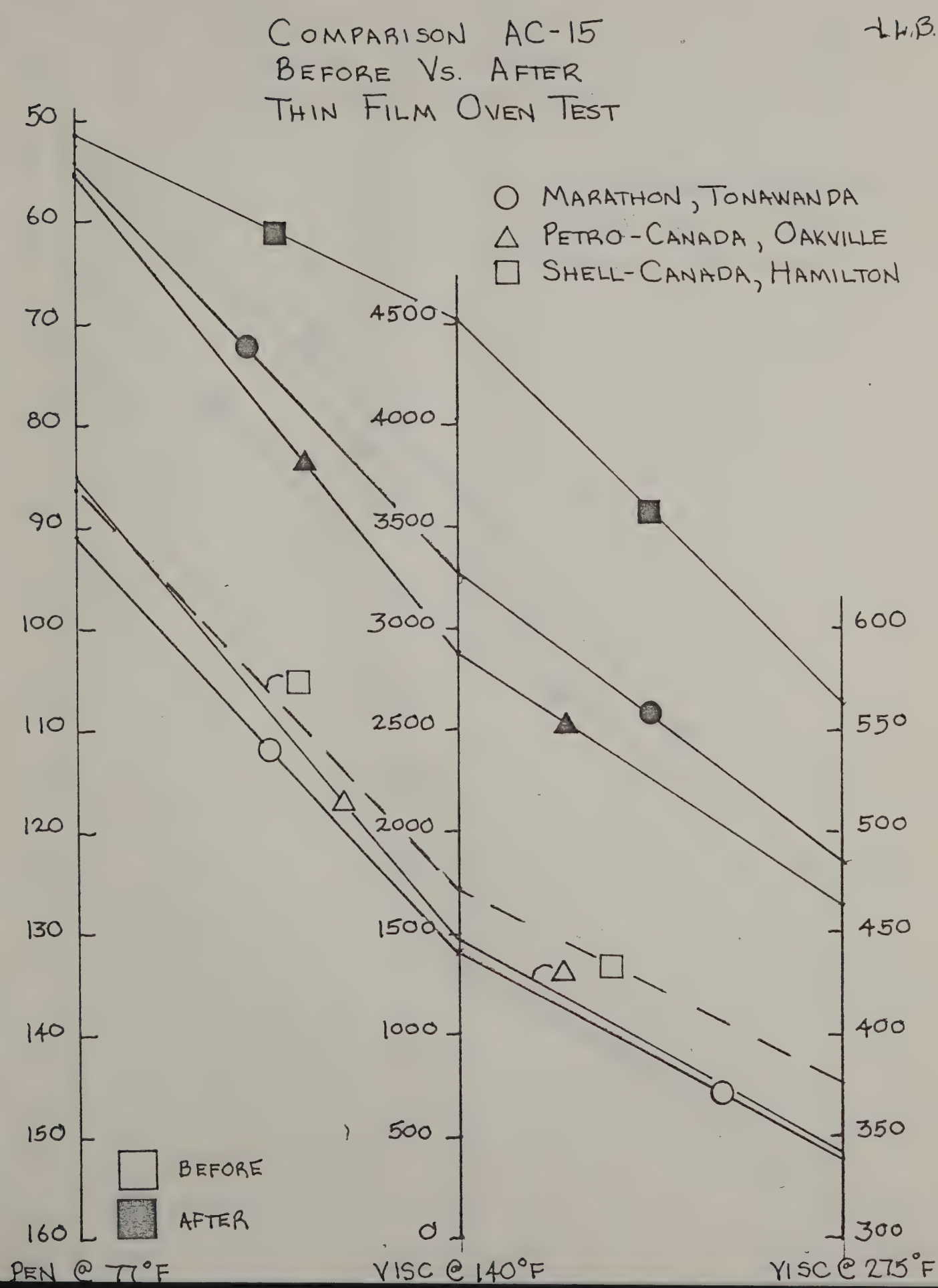
IX. GRAPHS AND CHARTS OF RELATED MATERIAL INFORMATION

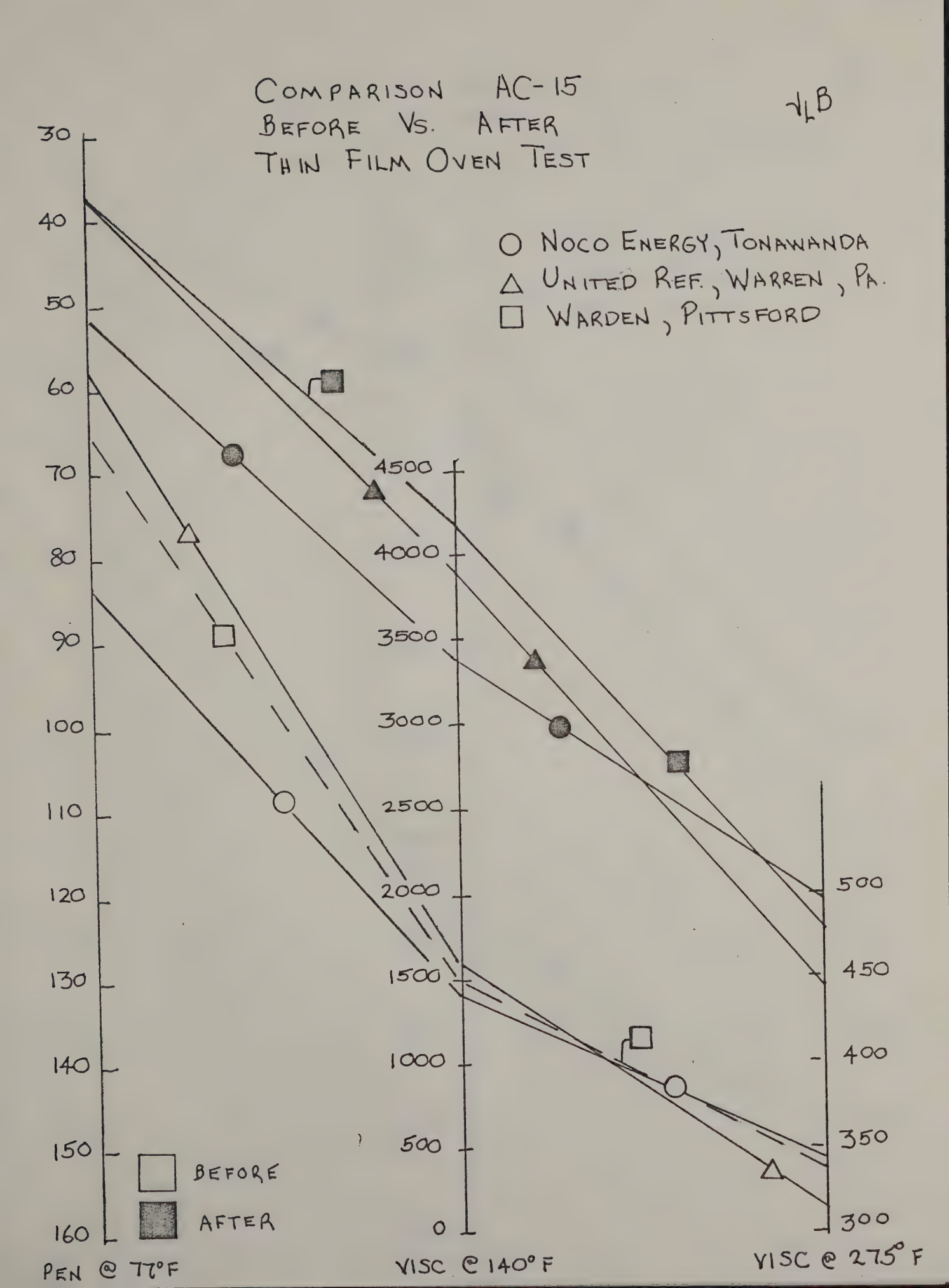
On the following pages are found a series of graphs providing a comparison of thin film oven test, before and after, and charts showing asphaltene dispersion settling test.

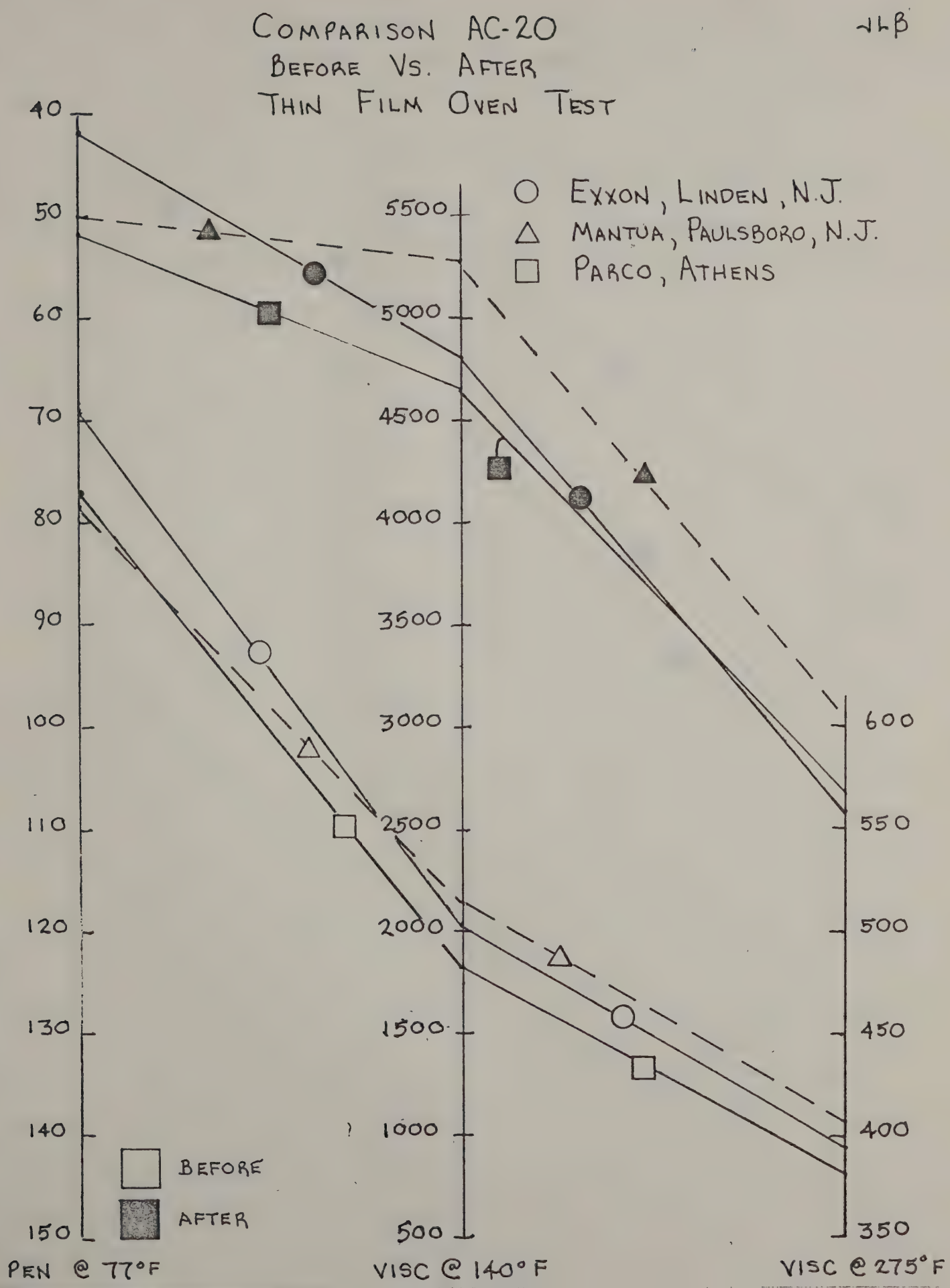

COMPARISON FLUX,
BEFORE VS. AFTER
THIN FILM OVEN TEST
O CHEVRON, P. AMBOY
△ CIBRO, ALBANY
□ MARATHON, TONAWANDA
BEFORE
AFTER
PEN @ 77°F
VISC. @ 140°F
VISC. @ 275°F
60
70
80
90
100
110
120
130
140
150
160
170
180
190
4000
3500
3000
2500
2000
1500
1000
500
0
650
600
550
500
450
400
350
300
250
200
150

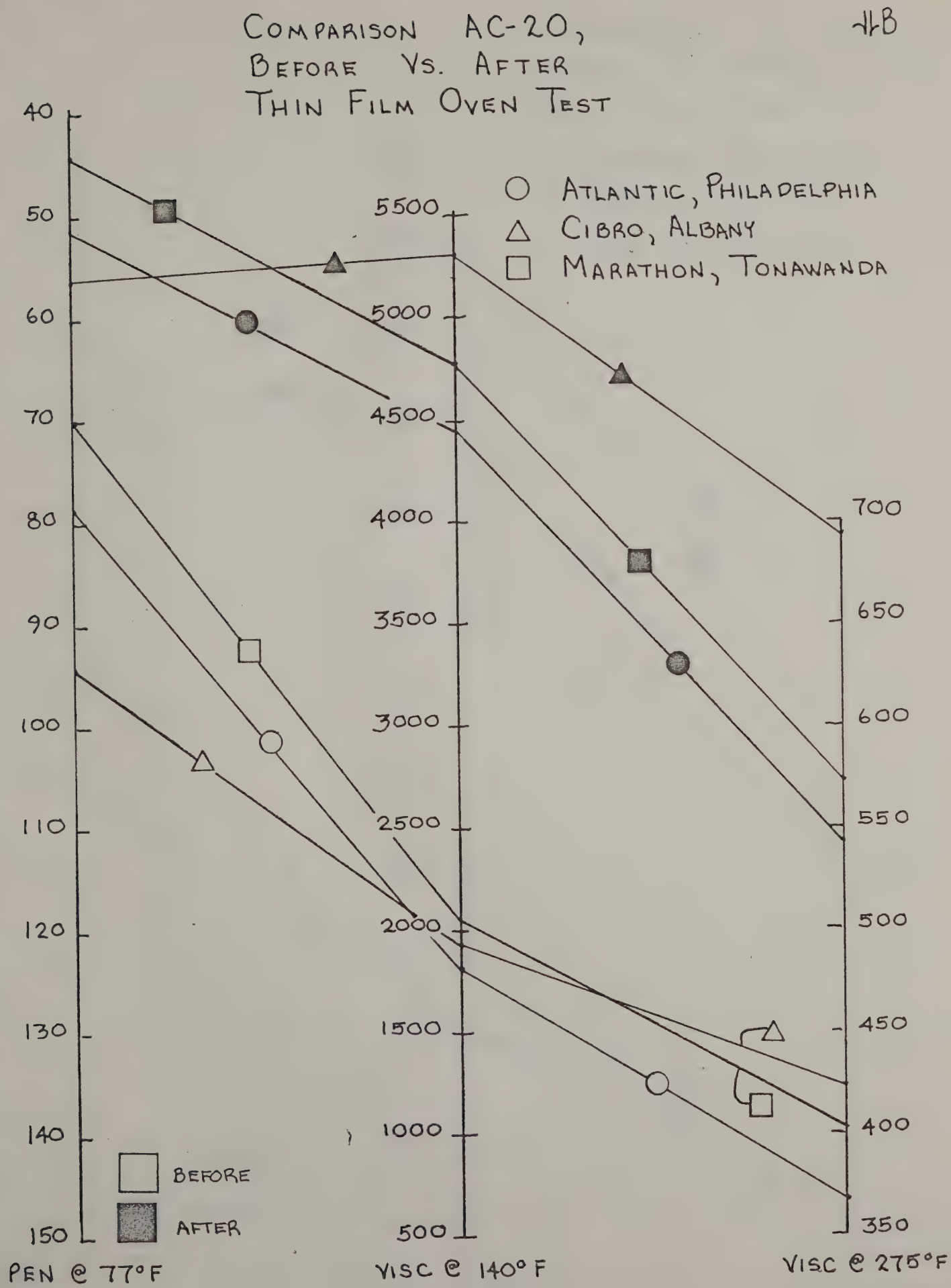

COMPARISON AC-5
BEFORE VS. AFTER
THIN FILM OVEN TEST
HLB
O PARCO, ATHENS
△ PETRO-CANADA, OAKVILLE
90
100
110
120
130
140
150
160
170
180
2000
1500
1000
500
0
400
350
300
250
200
BEFORE
AFTER
PEN @ 77°F
VISC. @ 140°F
VISC @ 275°F

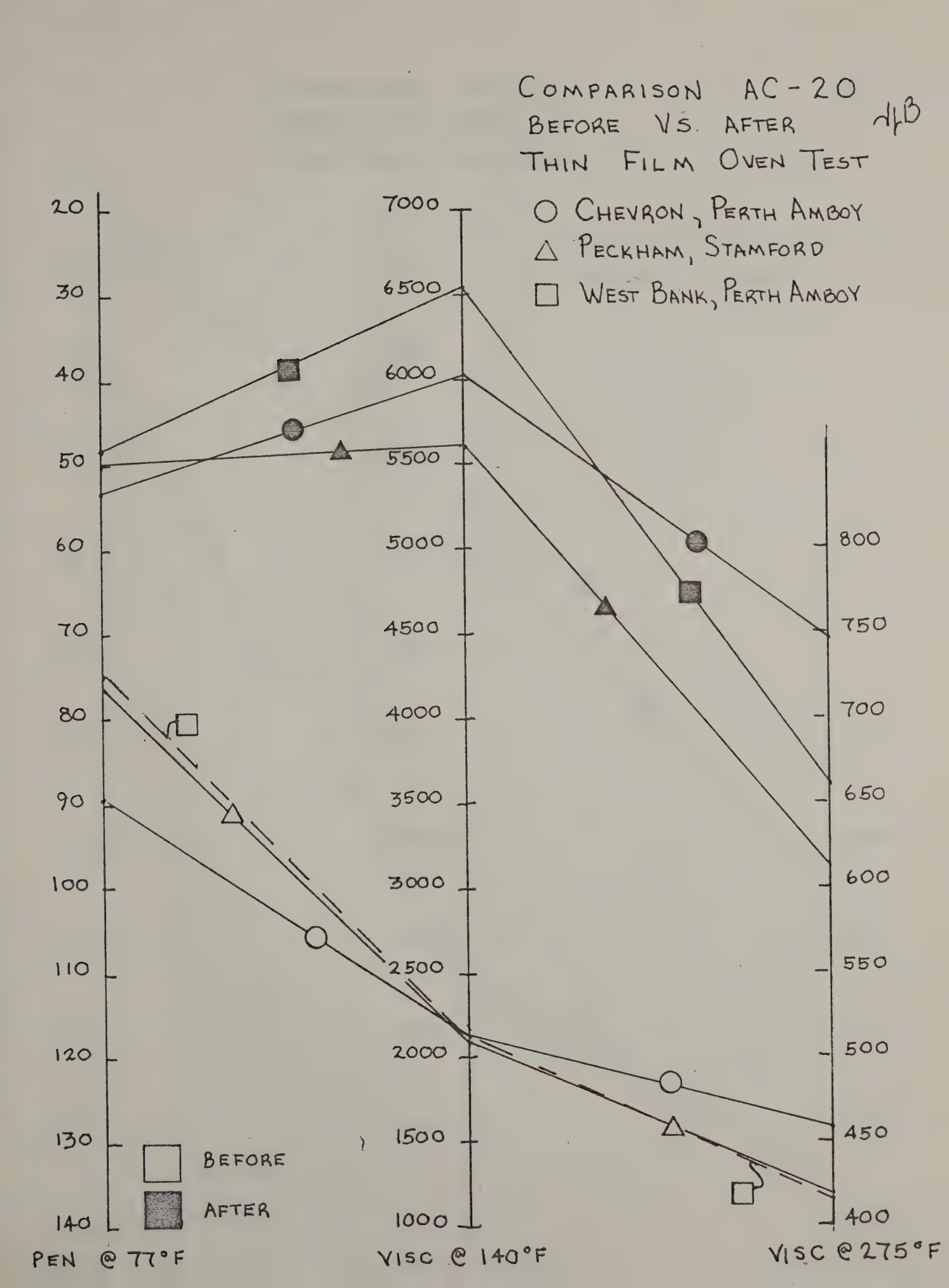

COMPARISON AC-10
BEFORE VS. AFTER
THIN FILM OVEN TEST
HLB
PARCO, ATHENS
PETRO-CANADA, MONTREAL
BEFORE
AFTER
50
60
70
80
90
100
110
120
130
140
150
160
PEN @ 77°F
4000
3500
3000
2500
2000
1500
1000
500
0
VISC @ 140°F
550
500
450
400
350
300
VISC @ 275°F

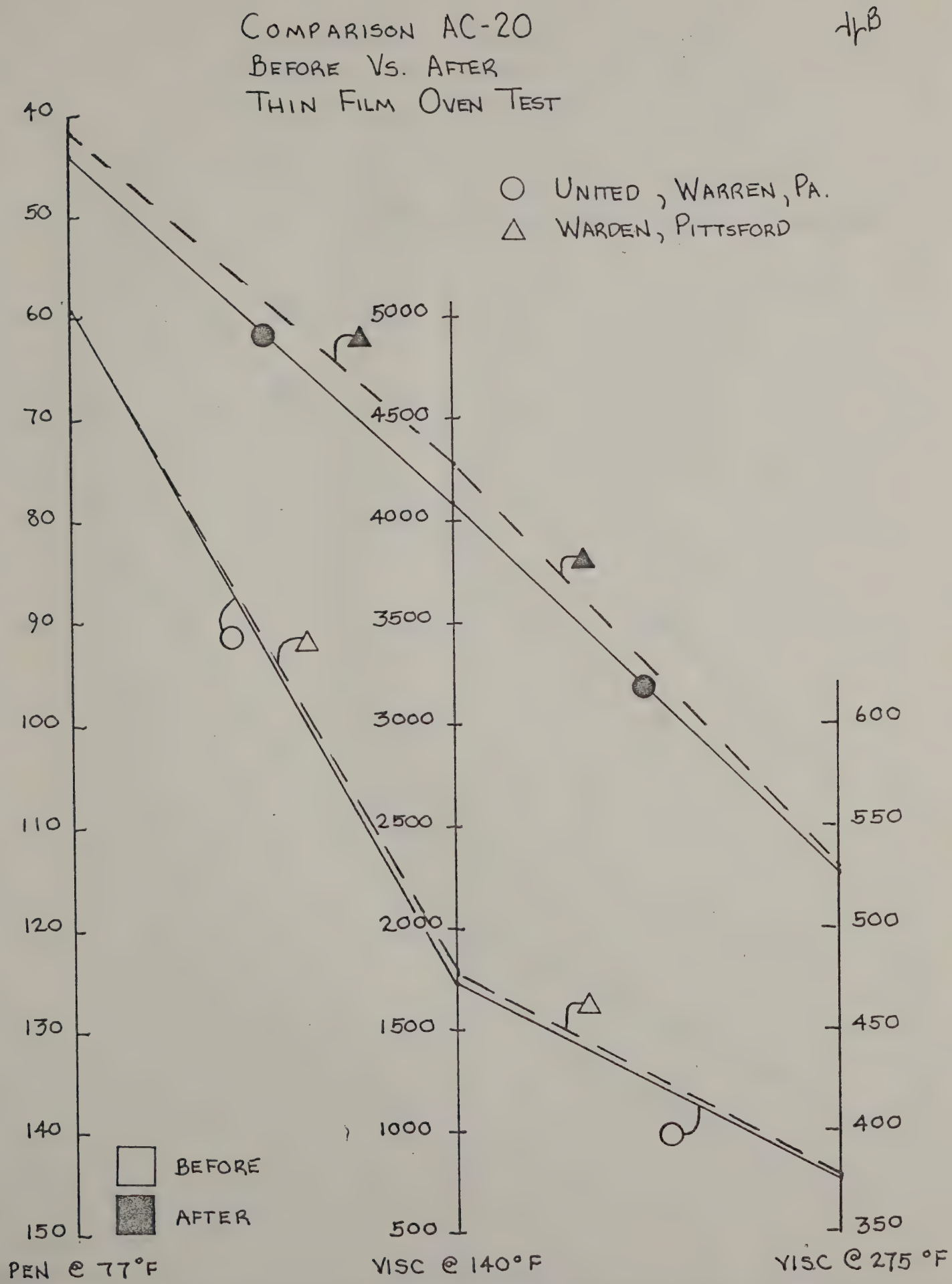

COMPARISON AC-15
BEFORE VS. AFTER
THIN FILM OVEN TEST
L.K.B.
MARATHON, TONAWANDA
PETRO-CANADA, OAKVILLE
SHELL-CANADA, HAMILTON
BEFORE
AFTER
50
60
70
80
90
100
110
120
130
140
150
160
PEN @ 77°F
4500
4000
3500
3000
2500
2000
1500
1000
500
0
VISC @ 140°F
600
550
500
450
400
350
300
VISC @ 275°F

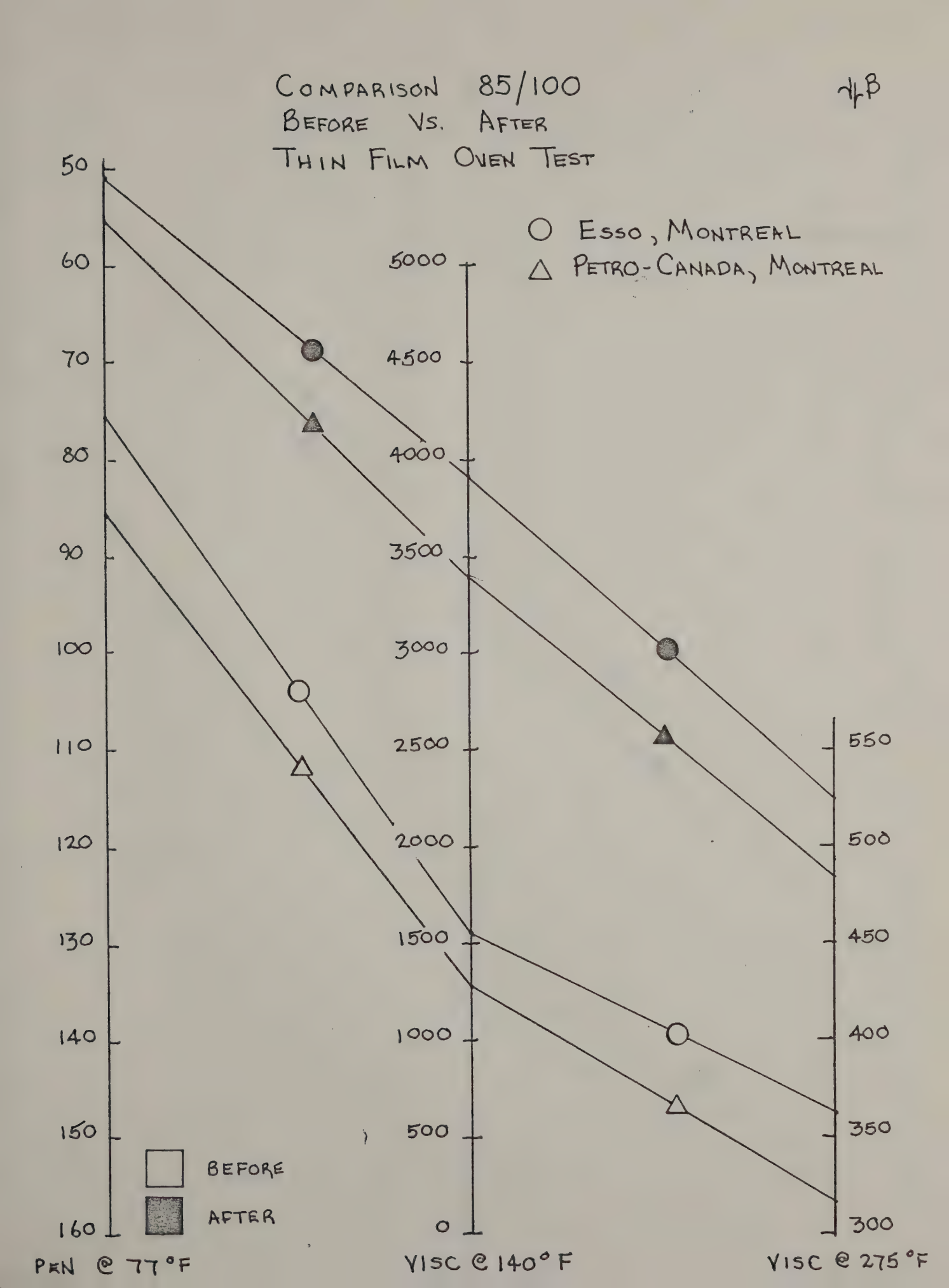

COMPARISON AC-15
BEFORE VS. AFTER
THIN FILM OVEN TEST
JLB
O NOCO ENERGY, TONAWANDA
△ UNITED REF., WARREN, PA.
□ WARDEN, PITTSFORD
BEFORE
AFTER
30
40
50
60
70
80
90
100
110
120
130
140
150
160
PEN @ 77°F
4500
4000
3500
3000
2500
2000
1500
1000
500
0
VISC @ 140° F
500
450
400
350
300
VISC @ 275° F


COMPARISON AC-20
BEFORE VS. AFTER
THIN FILM OVEN TEST
JLB
EXXON, LINDEN, N.J.
MANTUA, PAULSBORO, N.J.
PARCO, ATHENS
BEFORE
AFTER
40
50
60
70
80
90
100
110
120
130
140
150
PEN @ 77°F
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
VISC @ 140°F
600
550
500
450
400
350
VISC @ 275°F

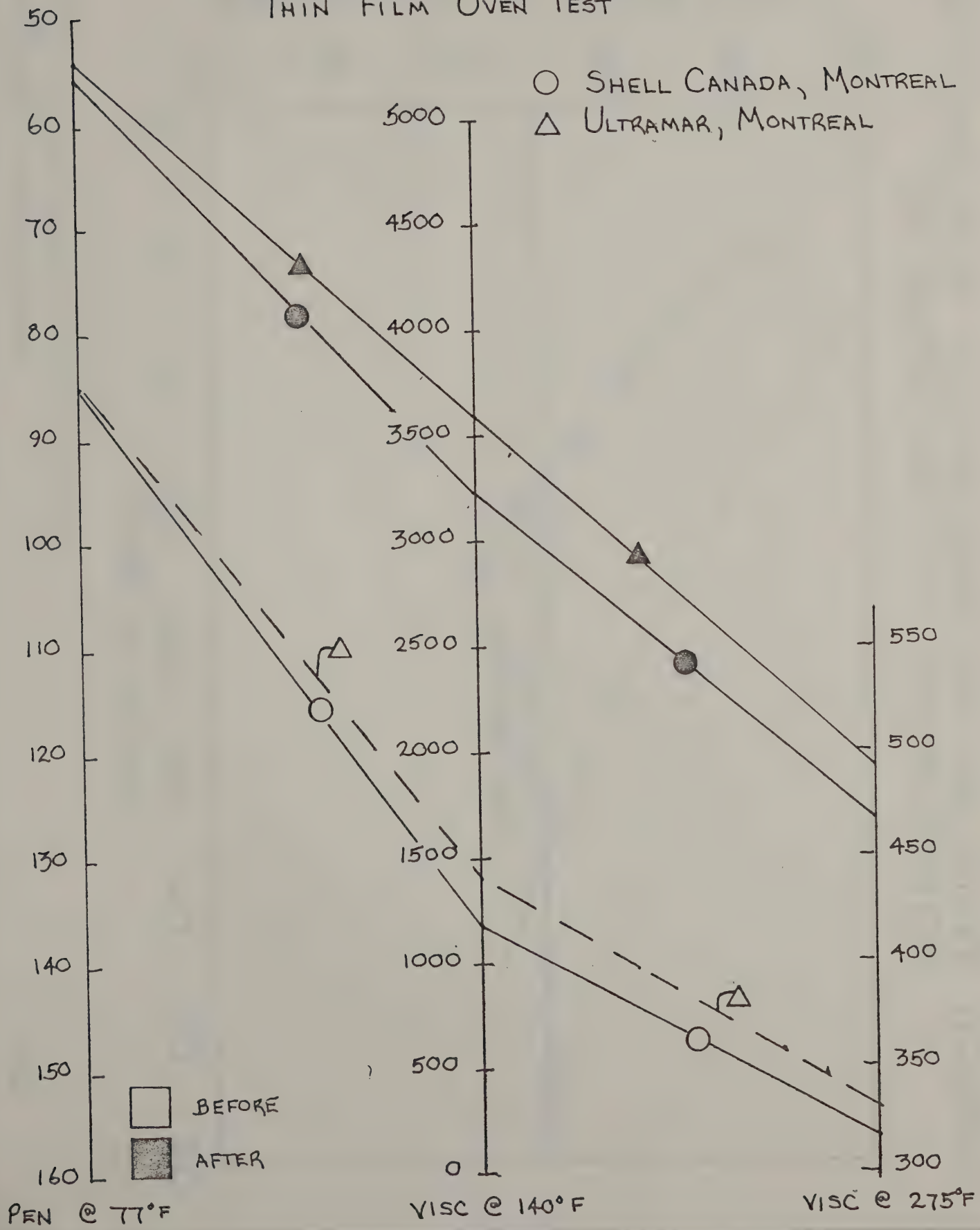

COMPARISON AC-20,
BEFORE VS. AFTER
THIN FILM OVEN TEST
HB
ATLANTIC, PHILADELPHIA
CIBRO, ALBANY
MARATHON, TONAWANDA
BEFORE
AFTER
40
50
60
70
80
90
100
110
120
130
140
150
PEN @ 77°F
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
VISC @ 140° F
700
650
600
550
500
450
400
350
VISC @ 275°F


COMPARISON AC-20
BEFORE VS. AFTER
THIN FILM OVEN TEST
dJB
CHEVRON, PERTH AMBOY
PECKHAM, STAMFORD
WEST BANK, PERTH AMBOY
BEFORE
AFTER
20
30
40
50
60
70
80
90
100
110
120
130
140
PEN @ 77°F
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
VISC @ 140°F
800
750
700
650
600
550
500
450
400
VISC @ 275°F

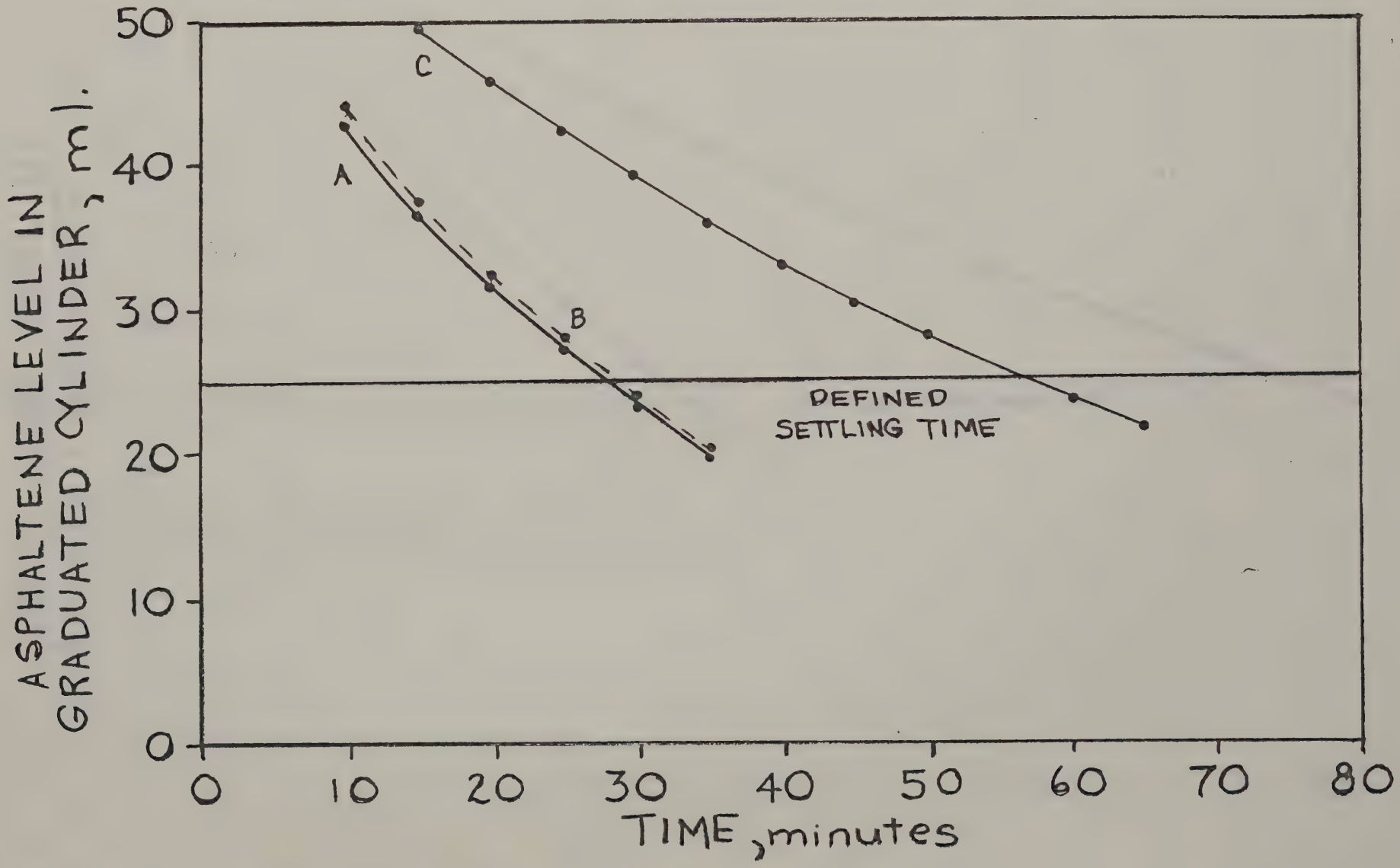

COMPARISON AC-20
BEFORE VS. AFTER
THIN FILM OVEN TEST
4B
UNITED, WARREN, PA.
WARDEN, PITTSFORD
BEFORE
AFTER
40
50
60
70
80
90
100
110
120
130
140
150
PEN @ 77°F
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
VISC @ 140°F
600
550
500
450
400
350
VISC @ 275°F


COMPARISON 85/100
BEFORE VS. AFTER
THIN FILM OVEN TEST
HB
ESSO, MONTREAL
PETRO-CANADA, MONTREAL
BEFORE
AFTER
50
60
70
80
90
100
110
120
130
140
150
160
PEN @ 77°F
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
VISC @ 140° F
550
500
450
400
350
300
VISC @ 275°F

Comparison 85/100 Before Vs. After Thin Film Oven Test



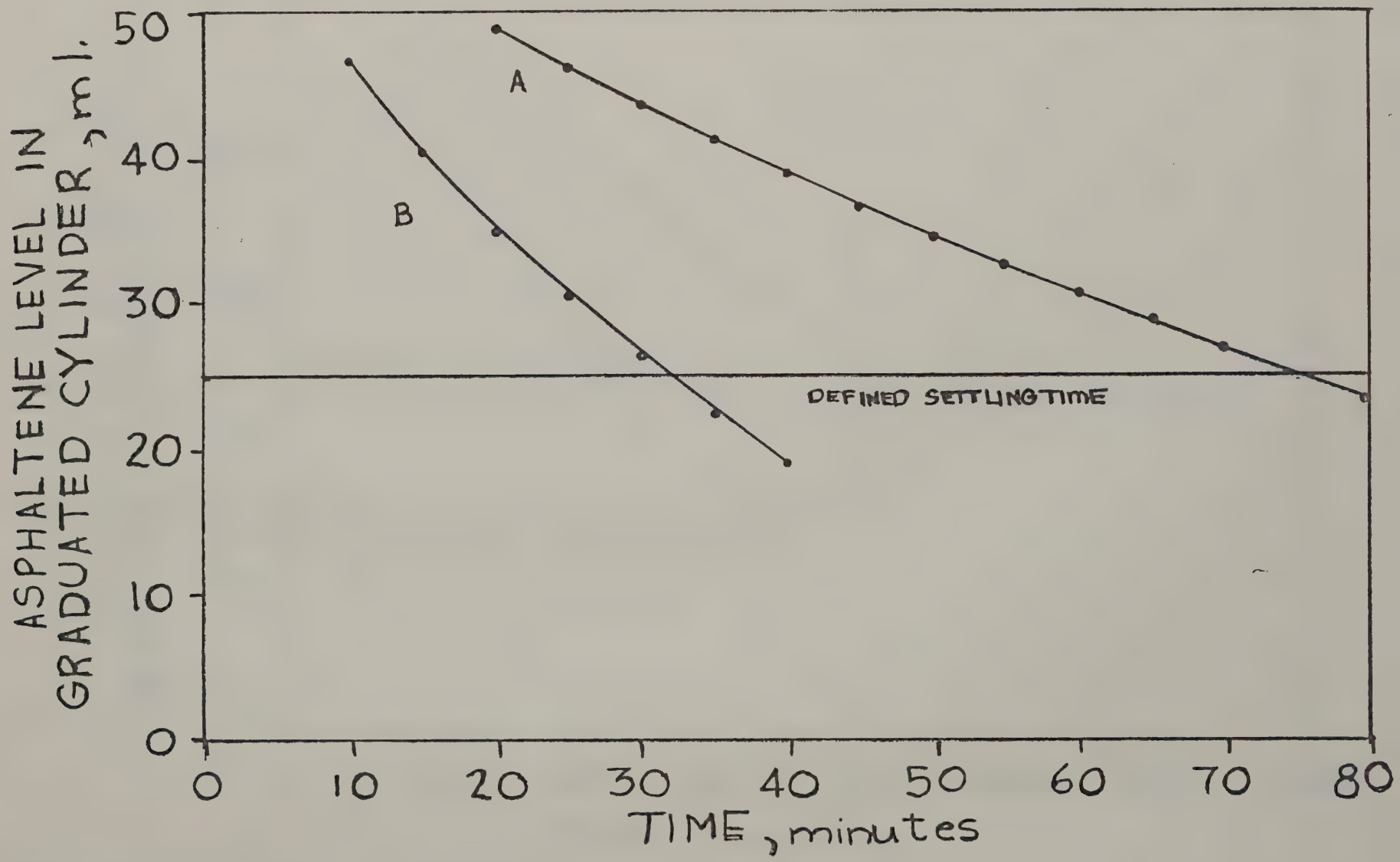
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = FLUX, CHEVRON, PERTH AMBOY
B = FLUX, CIBRO, ALBANY
C = FLUX, MARATHON, TONAWANDA

II-B

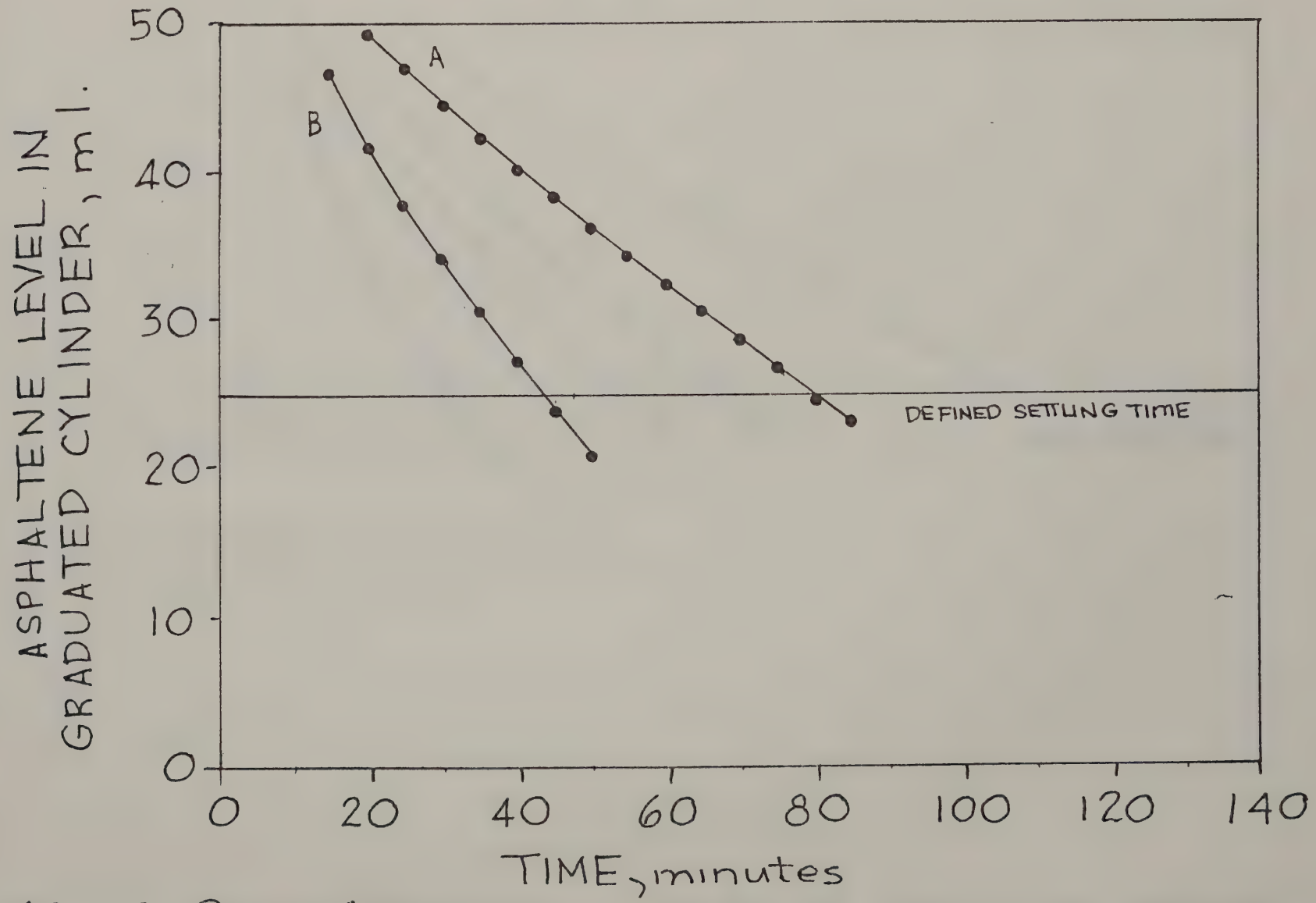
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = PARCO - ATHENS, AC-5
B = PETRO-CANADA, OAKVILLE, AC-5

JLB

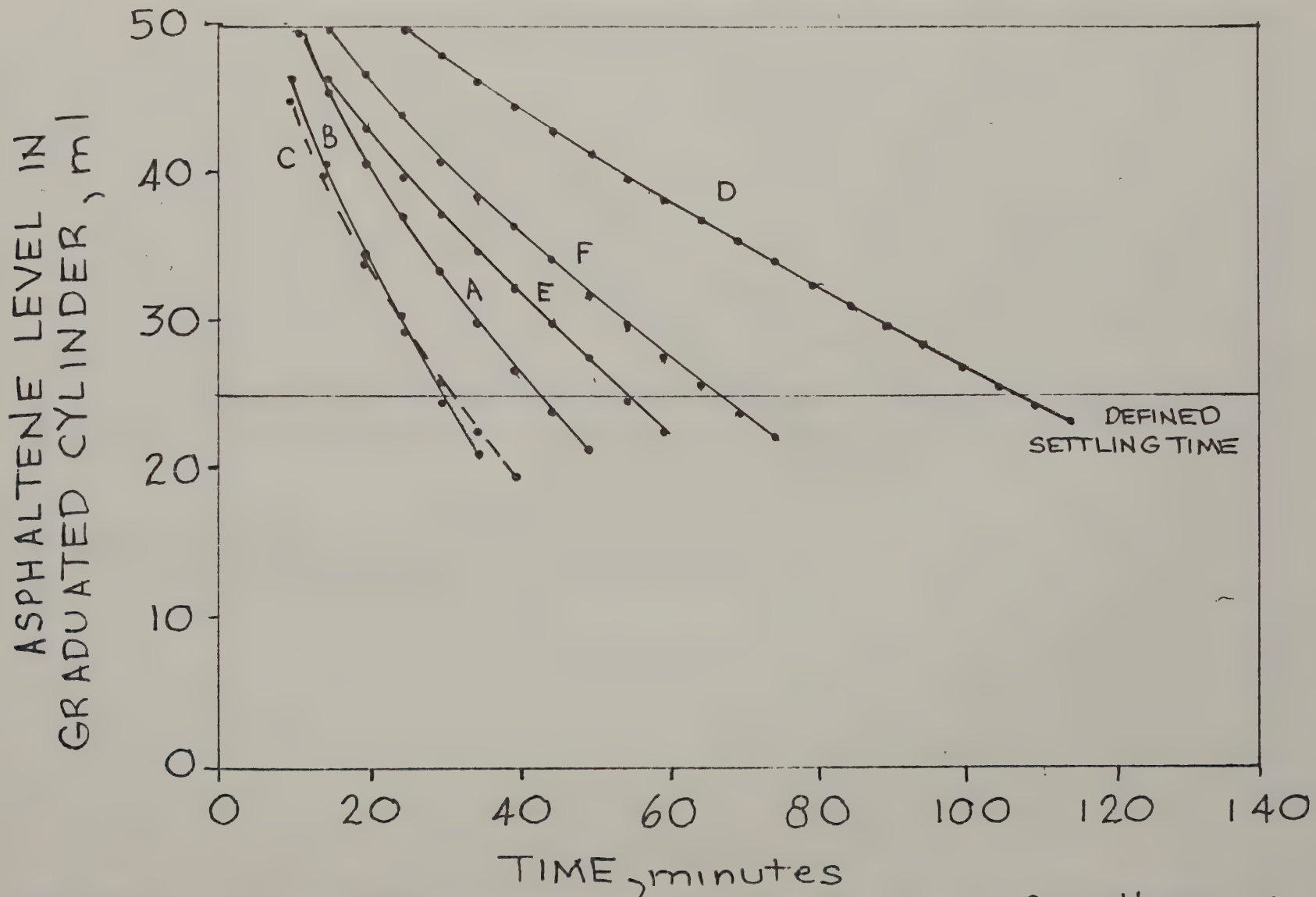
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-10, PARCO, ATHENS
B = AC-10, PETRO-CAN., MONTREAL

JLB

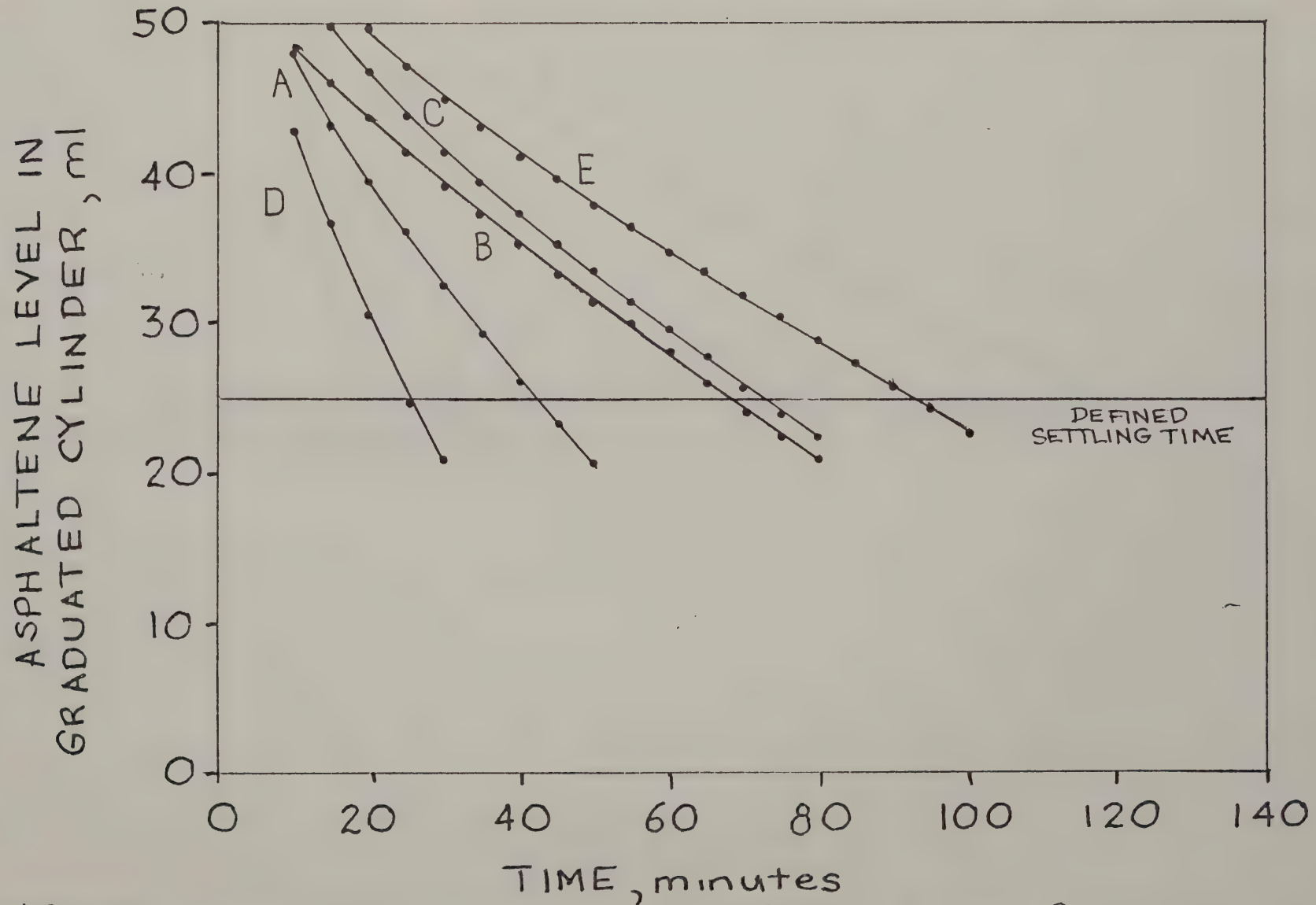
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-15, MARATHON, TONAWANDA
B = AC-15, NOCO, TONAWANDA
C = AC-15, PETRO-CAN., OAKVILLE
D = AC-15, SHELL-CAN., HAMILTON
E = AC-15, UNITED REF., WARREN
F = AC-15, WARDEN, PITTSFORD

JLB

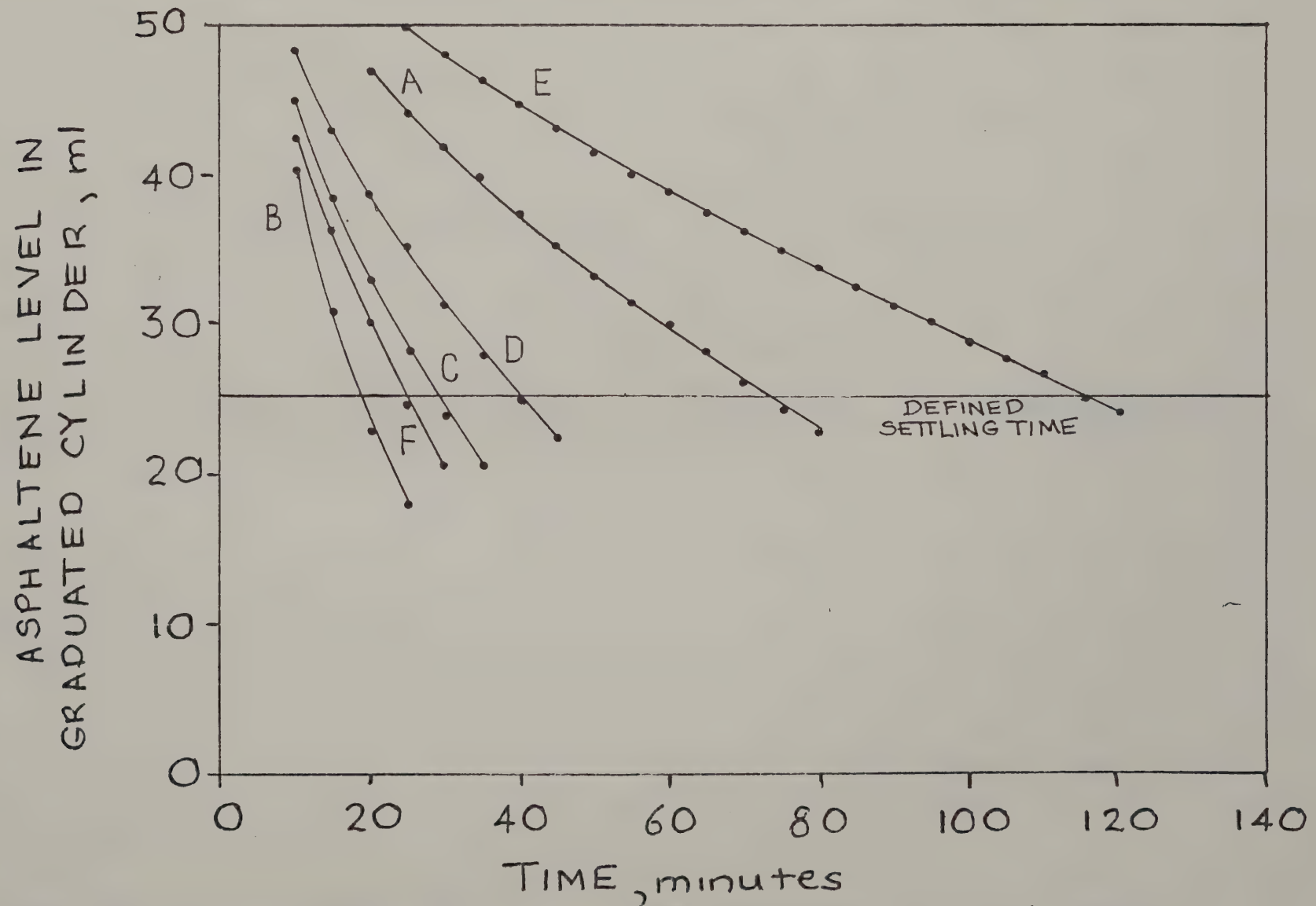
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-20, MARATHON, TONAWANDA
B = AC-20, PARCO, ATHENS
C = AC-20, PECKHAM, STAMFORD
D = AC-20, WARDEN, PITTSFORD
E = AC-20, WEST BANK, PERTH AMBOY

NLB

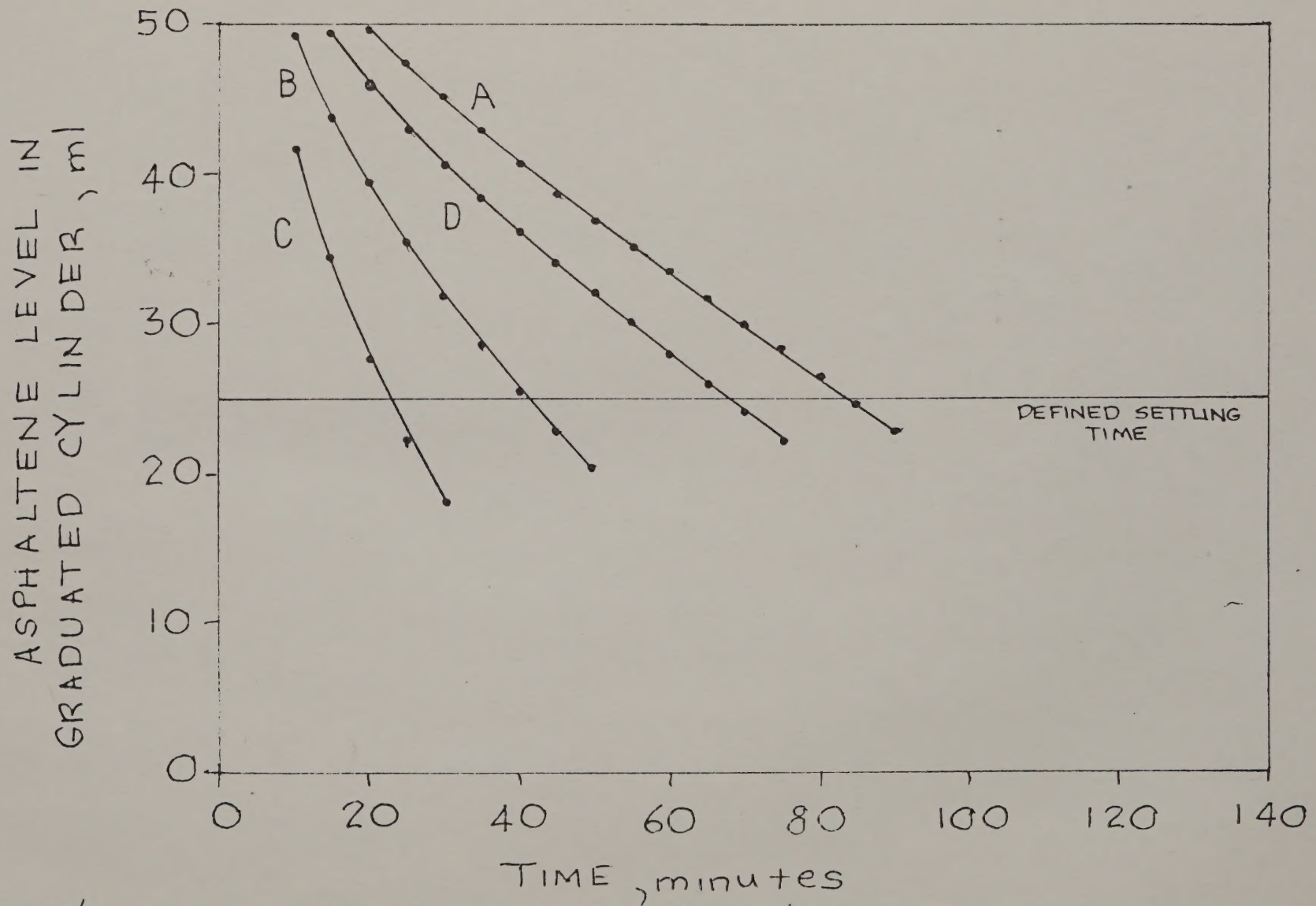
A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = AC-20, ATLANTIC, PHILADELPHIA
B = AC-20, CHEVRON, PERTH AMBOY
C = AC-20, CIBRO, ALBANY
D = AC-20, EXXON, LINDEN
E = AC-20, MANTUA, PAULSBORO
F = AC-20, UNITED, WARREN

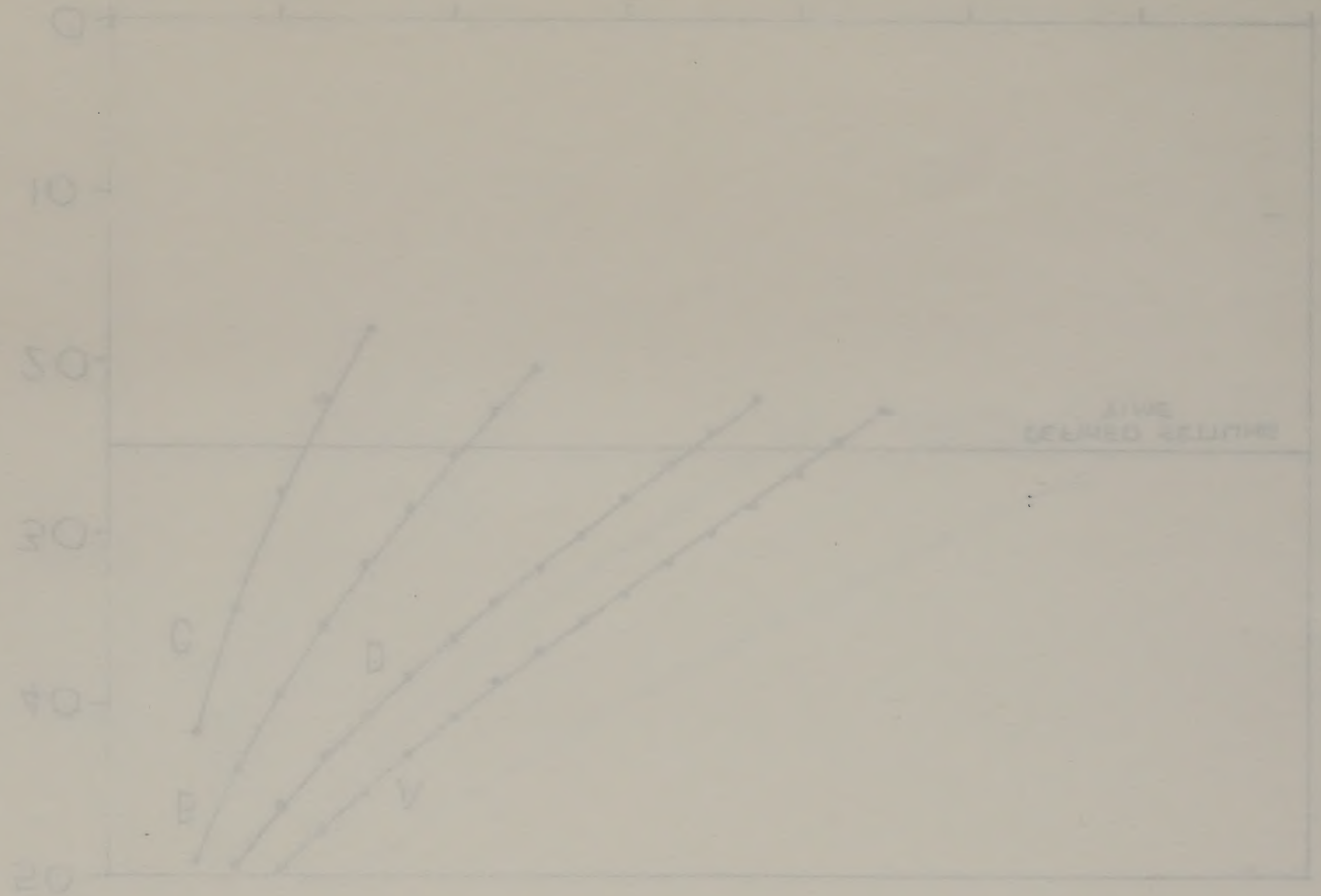
HB

A SETTLING TEST TO EVALUATE THE RELATIVE DEGREE OF DISPERSION OF ASPHALTENES



A = 85/100, Esso, Montreal
B = 85/100, Petro-Can., Montreal
C = 85/100, Shell-Can., Montreal
D = 85/100, Ultramar, Montreal

HB


0
10
20
30
40
50
C
B
A